No. 10. New Series. April 1879. [2s. 6d.

APR 21 1879

THE POPULAR
Science Review

EDITED BY W. S. DALLAS, F.L.S.

Assistant-Secretary of the Geological Society.

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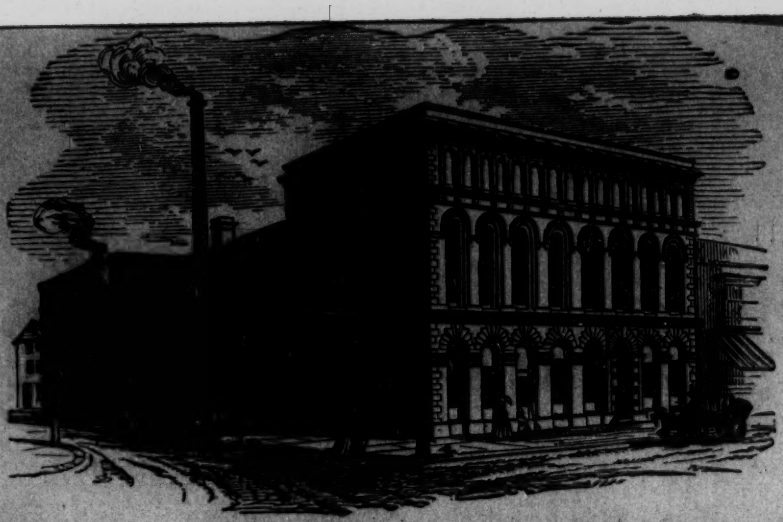

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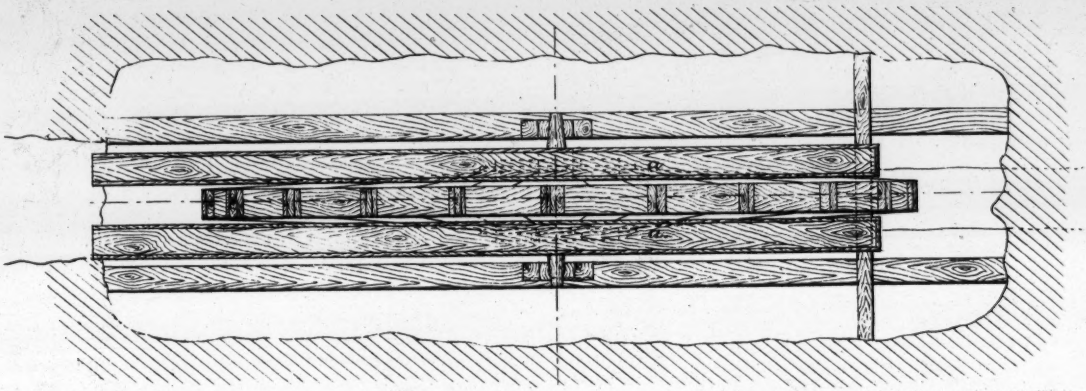
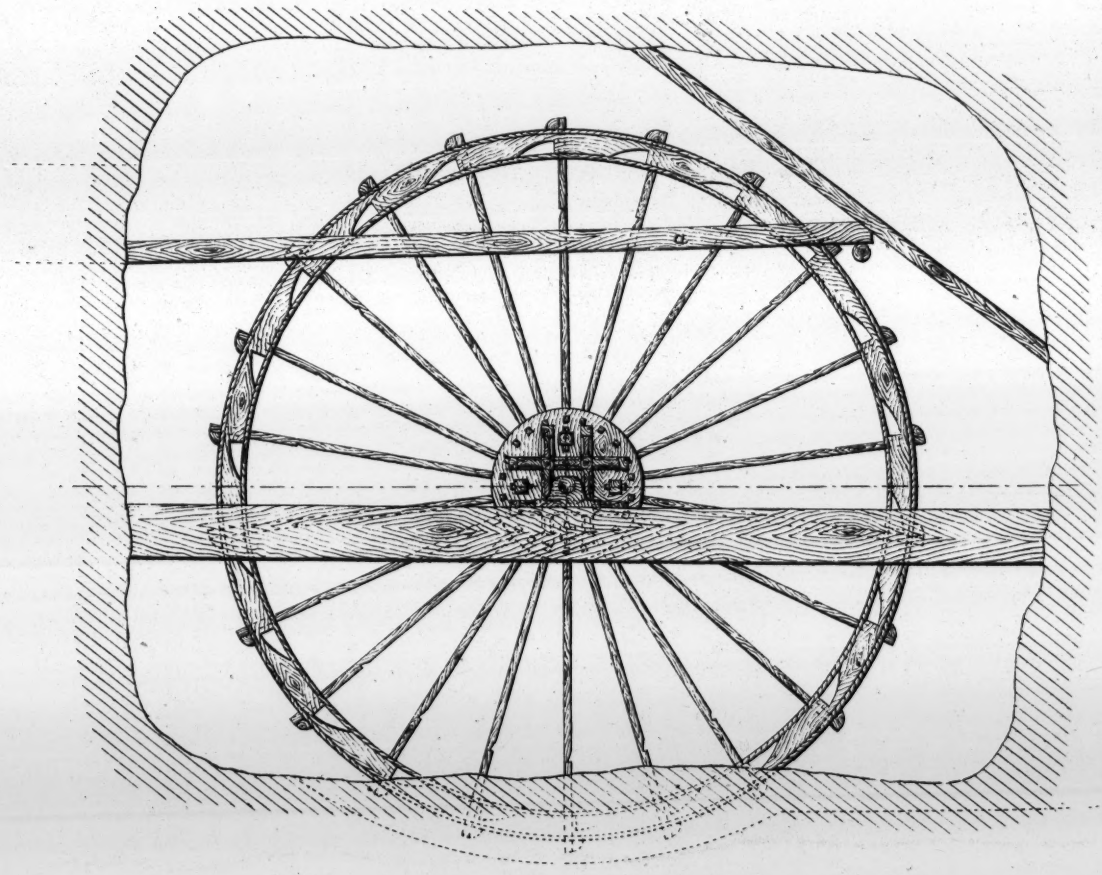




SIDE ELEVATION.

ANCIENT ROMAN DRAINAGE-WHEEL.

THE SOURCES AND USES OF IRON PYRITES.

By J. ARTHUR PHILLIPS, F.G.S.

[PLATES III. & IV.]

THE process still generally employed for the manufacture of carbonate of soda from common salt was the discovery of the French Chemist Leblanc, and was first carried out, on a large scale, by him and his partners in France. Previous to the revolution of 1789 the only kind of soda commercially known was that obtained from various marine plants, the greater portion of the raw material having been imported from the coast of Spain and Portugal.

The wars which were at that time ravaging Europe naturally had the effect of putting a stop to this branch of industry, and although, in case of need, potash may replace soda in the manufacture of glass and soap, the emergency of the times rendered it necessary that the whole of the available potash should be converted into saltpetre for the preparation of gunpowder.

With a view to meeting this very serious difficulty, the Committee of Public Safety called, by special proclamation, upon all citizens to place in the hands of commissioners for the public benefit, and without regard to private interests, whatever plans or methods of preparing soda might be known to any of them.

In consequence of this demand numerous schemes were laid before the Commissioners, who eventually reported that the method proposed by M. Leblanc appeared to be that best adapted for the manufacture of soda upon an extensive scale. This process consists in first converting chloride of sodium into sulphate of soda by the addition of sulphuric acid, and the subsequent decomposition of sulphate of soda, at a high temperature, by a mixture of limestone and dust coal.

In order to convert one ton of common salt into sulphate of

soda (salt cake), 16 cwt. of concentrated sulphuric acid (oil of vitriol) are required, and it therefore follows that with an active development of this new industry the demand for sulphuric acid and for the materials requisite for its production rapidly increased. In the preparation of this acid upon a large scale, sulphurous acid, obtained by burning sulphur or pyrites, is converted into sulphuric acid by means of a powerfully oxidising agent. The substance now universally employed for this purpose is nitric acid, although the greater portion of the oxygen utilised is not derived directly from the acid, but indirectly from the air; the result of complex chemical changes which take place in extensive leaden chambers supplied with watery vapour by means of steam jets.

Previous to 1838, sulphur was the material almost universally made use of in the production of oil of vitriol, but in that year the King of Naples having granted a monopoly of Sicilian sulphur to a French firm at Marseilles, it resulted in the gradual introduction of iron pyrites as a substitute for brimstone in the manufacture of sulphuric acid.

From that date to the present the consumption of this mineral has gone on steadily increasing; the mines of Cornwall and those of Wicklow in Ireland having been, during many years, the chief sources of supply. A certain amount was also obtained from Norway.

About the year 1853 small quantities of pyrites containing a little copper found their way into this country from mines worked by a French company in the South of Spain, but as their transit, on mule-back, to the shipping port was long, the supply was limited, and the results are believed to have been financially unsatisfactory.

A few years subsequent to this (1859), Mr. James Mason opened out the now celebrated mines of San Domingos in Portugal, and having connected it by railway with the river Guadiana, near the town of Pomaron, commenced an active competition with the pyrites from Cornwall, Wicklow, and Norway. The comparative freedom of this ore from arsenic, and the small proportion of gangue which it contains, caused it to be generally preferred to pyrites from other localities, so that the quantity imported into Great Britain in 1868 from this mine alone amounted to no less than 83,000 tons.

At this period the Tharsis Sulphur and Copper Company, who had now taken over the mines formerly worked by the French Company, already referred to, had not only commenced exporting pyrites from Spain, but had also erected various extensive works in this country for the extraction of copper, by a humid process, from the cinder, or residue, remaining in the kilns of sulphuric acid manufacturers after the removal of sulphur

and oxidation of its associated iron. The Buitron Company, whose mines are situated in the same province of Huelva, also for a short time contributed a considerable amount of pyrites to this market, but the largest undertaking in connection with mining for this mineral is unquestionably that of the Rio Tinto Company, commenced in 1873.

The deposits belonging to this association are situated near a town of that name, 84 kilometres, or 52 miles, north of the port of Huelva, at the mouth of the river Odiel, with which they are connected by a railway. In this part of Spain the deposits of cupreous pyrites consist of a series of more or less continuous lenticular masses of ore, possessing a general direction a little north of east, and south of west, extending from Aznalcollar near Seville, in the east, for a distance of more than 70 miles westward, to the well-known mines of San Domingos, within the Portuguese frontier.

The substance of these deposits consists of an intimate and compact admixture of iron pyrites with a little copper pyrites through which strings of the latter mineral are sometimes observed to ramify; small veins of black sulphide of copper less frequently traverse the mass. Galena and blende are also present, as well as arsenical pyrites in small quantity; and in the ancient workings great quantities of blue and green vitriols are met with, as a product of oxidation of the ore by the action of air and water.

As already stated, these lodes may be regarded as enormous lenticular masses of cupreous pyrites, in which small strings of copper ores containing from 5 up to 40 per cent. of that metal are occasionally met with, but more particularly in the vicinity of the walls and in the neighbourhood of quartz veins. This fact was evidently known to the Romans, who entirely confined their operations to such rich ores, and neglected the general mass of the lodes which does not contain much above 2 per cent. of copper.

The prevailing rocks throughout the entire district are clay slates, which, from some imperfect fossils recently discovered in them, would appear to be of Silurian age. These slates are in places disturbed by dykes of diabase and quartz-porphyry, the latter rock frequently forming one of the walls of the metalliferous lode.

These deposits have, almost without exception, been wrought in remote antiquity, the workings having in some exceptional cases reached a depth of nearly 50 fathoms beneath the surface. The larger proportion of these ancient excavations are manifestly of Roman origin, although the occasional discovery of stone implements would appear to indicate that the ferruginous capping of the veins furnished a red pigment to the early in-

habitants of the country at a still more remote period. Among the objects of this description found in the overburden above the outcrop of the south lode at Rio Tinto was a slab of hæmatite about nine inches square and three in thickness, on the surface of which were two rows of regularly arranged depressions, each about two inches in diameter. These had evidently been made by the action of a small muller of coarse porphyry which was found alongside; doubtless, forming an arrangement by which a red pigment was readily obtained by mixing with a little water the material ground from the substance of the slab.

The Roman workings consist of numerous circular shafts, sometimes where necessary lined with stone, and seldom more than thirty inches in diameter; these are in connection with various tortuous galleries which invariably follow the direction of rich branches of ore. By becoming saturated with waters holding copper salts in solution, the woodwork of these mines has been wonderfully preserved, while its tissue is often more or less permeated by metallic copper resulting from the reduction of its sulphates by woody fibre. In this way timbers made use of for supporting the ground are sometimes in such good preservation as to retain marks made upon them sixteen centuries ago, and letters cut by Roman miners are almost as fresh as those carved by a school-boy of the present day.

The Roman method of drainage was partly by adits, of which several of great length are known to exist; but they also employed various mechanical means for the removal of water below the level of such outlets. A curious discovery of machinery of this class was made some years since in the mine of San Domingos where a number of wheels constructed entirely of wood, and each 16 feet in diameter, were found placed one above another in large cisterns or troughs. Through the kindness of Messrs. Mason and Barry I am enabled to give an illustration of one of these wheels from a drawing made upon the spot. Plate III. represents a plan and elevation of one of these remnants of early engineering, as placed in the mines.

This wheel is constructed entirely of wood, and closely resembles an ordinary water-wheel with the buckets reversed; only that as the internal and external rings are complete throughout, the water, when once taken up, can only escape by the openings shown in the sides. In this way water which has entered the buckets, while that portion of the periphery was passing through the well, on being raised to the height of the two troughs or launders *a*, flows into them through these openings in the sides of the wheel, and is conveyed by them into another trough at a slightly lower level. It is consequently evident that by the use of a number of such wheels, one placed higher than another, and all turned at the same time by means of

their radiating arms, water could be raised from considerable depths. Ten of these wheels have been discovered at San Domingos; eight of them were 16ft. in diameter, and the other two 12ft. 6in.

The remains of another Roman contrivance for the drainage of water were discovered some years since in one of the Spanish mines near Seville. This arrangement consisted of a number of Archimedean screws which, one after another, raised the water from a series of wooden tanks lined with sheet lead. The whole of this apparatus, with the exception of the leaden lining of the cisterns, was composed of wood fastened with oaken pegs, and sometimes strengthened by ropes of esparto grass; the constructors thus evidently showing they were aware that iron was unfitted for this purpose in the presence of cupreous waters by which it is rapidly acted upon.

Earthenware lamps of Roman workmanship are constantly found in the old workings of the mines, while vessels and implements of copper or bronze are occasionally met with; less frequently human bones are exposed, which, by the action of copper salts upon their calcic phosphate, have assumed an appearance approaching that of turquoise. It may be mentioned also that some years since a bronze plate was found at the entrance of a crushed Roman gallery at Rio Tinto, which stated it had been begun during the reign of Cocceius Nerva, A.D. 96–98. This plate is now in the collection of the School of Mines at Madrid.

The Roman metallurgist smelted his ores in the immediate vicinity of the mines from which they were obtained, and the discovery of the foundations of blast-furnaces, as well as of fragments of earthen *tuyères*, renders it probable that a blast of some kind was used. This is confirmed by the form assumed by the cakes of slag, of which vast heaps are piled up in the neighbourhood of all the principal pyrites mines of Spain; these slag-heaps are usually situated above the level of the water-courses of the district, from which it may be inferred, either that the blast was obtained by manual labour, or that a furnace allied to the modern *pavo*, still used for smelting lead ores and slags in the neighbourhood of Carthagena, was employed.

The extent of the mining and metallurgical operations, anciently carried out in this portion of Southern Spain, will be readily understood when it is stated that the slag-heaps in close proximity to Rio Tinto cannot weigh less than a million and a half tons, and that there are large, although less extensive, deposits at Tharsis, Buitron, and various other localities. That, at least, a portion of the labour of these establishments was performed by slaves is abundantly evident from the repeated discovery of skeletons still retaining their chains. At a

distance of one hundred and fifty yards from the principal slag-heaps at Rio Tinto, the foundations of extensive buildings may be readily traced, and a little beyond them is a Roman cemetery in which thousands of interments must, at various times, have taken place. On a portion of this ground, over which are strewed the columns of a ruined temple, broken tombstones of ferruginous conglomerate are abundant; but the inscriptions, which were on metal plates, of which indications are still visible, have in every case been removed. In this part of the cemetery all the graves have been long ago opened and their contents removed, but wherever the ground is disturbed in the surrounding oak wood, which covers several acres, stone cists are found containing burnt bones, pottery, glass vessels, leaden plummets, links of iron chain, and pieces of litharge.

The presence of litharge in these tombs, which are of undoubtedly Roman age, with the occasional discovery of pigs of Roman lead, renders it more than probable that the then high price of gold and silver enabled the metallurgist of that day to extract with advantage the extremely small amount of these metals present in the pyrites of Rio Tinto. This was probably effected by liquation and the subsequent cupellation of the resulting lead.

Forgetting the difference in the value of metals then and now, overlooking the cheap labour of Roman times, and taking for granted that work done so long ago must of necessity have been done badly, the idea has presented itself to various amateur metallurgists that such slags might be re-smelted with advantage. The analysis of an average sample of these Roman slags, by Mr. G. W. H. Clement, formerly chemist to the Rio Tinto Co., is however sufficient not only to show the great skill of these ancient artificers, but also to demonstrate the utter futility of any attempt to re-treat their residues. The results obtained were as follows:—

Water	1·05
Silica	32·02
Alumina	6·85
Lime	2·23
Magnesia	·31
Ferrous oxide	50·02
Ferric oxide	4·48
Plumbic oxide	1·00
Cupric oxide	·18
Metallic iron	·45
Ferrous sulphide	1·35
Alkalies	·28
	100·22

The above analysis indicates that in every ton of slag there are about 3 lbs. of copper, which, if it were possible to recover

the whole, would be worth say 1*s.* 8*d.*; a sum far too small to cover the cost of any known method of treatment.

At the present time all the principal pyrites deposits are worked as large quarries or open cuttings from which a certain amount of overburden has to be removed, while the mineral is transported by locomotive power over railways connecting the mines with their respective shipping ports. The very extensive scale upon which they are now conducted will be gathered from the following figures.

At Tharsis, during the year 1877, no less than 371,230 cubic yards of overburden were removed and 435,876 tons of pyrites extracted; of this amount 249,299 tons were shipped for the use of alkali manufacturers, manure makers, &c., while 186,577 tons were retained for local treatment for copper. In addition to this 45,415 tons of ore were extracted and treated at Calañas, while the amount of copper precipitate exported amounted to 7,199 tons.

The total quantity of pyrites raised during 1877 from the Tharsis and Calañas mines was 481,920 tons, and the average number of work-people employed throughout the year 3,181, embracing a population of about 6,500 either resident on or dependent upon the mines.

The Rio Tinto mines, like the Tharsis, are worked *à ciel ouvert*, and during the year 1877, 773,366 cubic yards of overburden were removed as well as 771,751 tons of pyrites extracted; of this amount 251,360 tons were exported, and 520,391 tons retained for local treatment. During the same period copper precipitate representing 2,735 tons of metallic copper was exported, and at the close of the present year the annual production of metallic copper will probably not have fallen short of 6,500 tons.

At the San Domingos mines the total production of pyrites in 1877 was 341,000 tons, of which 163,000 tons were exported, while the copper precipitate shipped amounted to 3,050 tons; as in the case of the Rio Tinto works, the local production of copper during the current twelve months will be much larger than in 1877.

The largest deposits of pyrites are those of Rio Tinto, where three very wide and nearly parallel lodes are known to exist; of these, however, the more southerly only is at present worked. Hundreds of Roman shafts are scattered over the outcrop of the central and northern deposits, and it is believed that a very large proportion of the ores which have furnished the vast heaps of ancient slags accumulated in this vicinity were obtained from these lodes.

At San Domingos and Tharsis the mines were found by the present proprietors in the exact state in which they were left

by the Roman workmen, whereas at Rio Tinto they had been partially worked by the Spanish Government up to the time of their transfer to the English company. The south lode is, however, the only portion of the property which has been worked in modern times, and the portion which has been recently uncovered has to a considerable extent been honey-combed by Roman and Spanish workings as far down as the ninth floor. This has had the effect of, to some extent, bleeding the vein by the continual drainage of copper water which has for many years produced, by precipitation, about three-and-a-half tons of metallic copper weekly.

That portion of the vein which was selected by the late Mr. David Forbes F.R.S. for an open cutting is about 200 fathoms in length and is, in the widest part, about 47 fathoms in width; the outcrop of this deposit is 45 fathoms above the valley of the Rio Agrio, with which the workings communicate by a large drainage-tunnel in which a double line of rails has been laid down. The total yield of this portion of the lode to the level of the valley was, when first opened, calculated at about 11,000,000 tons.

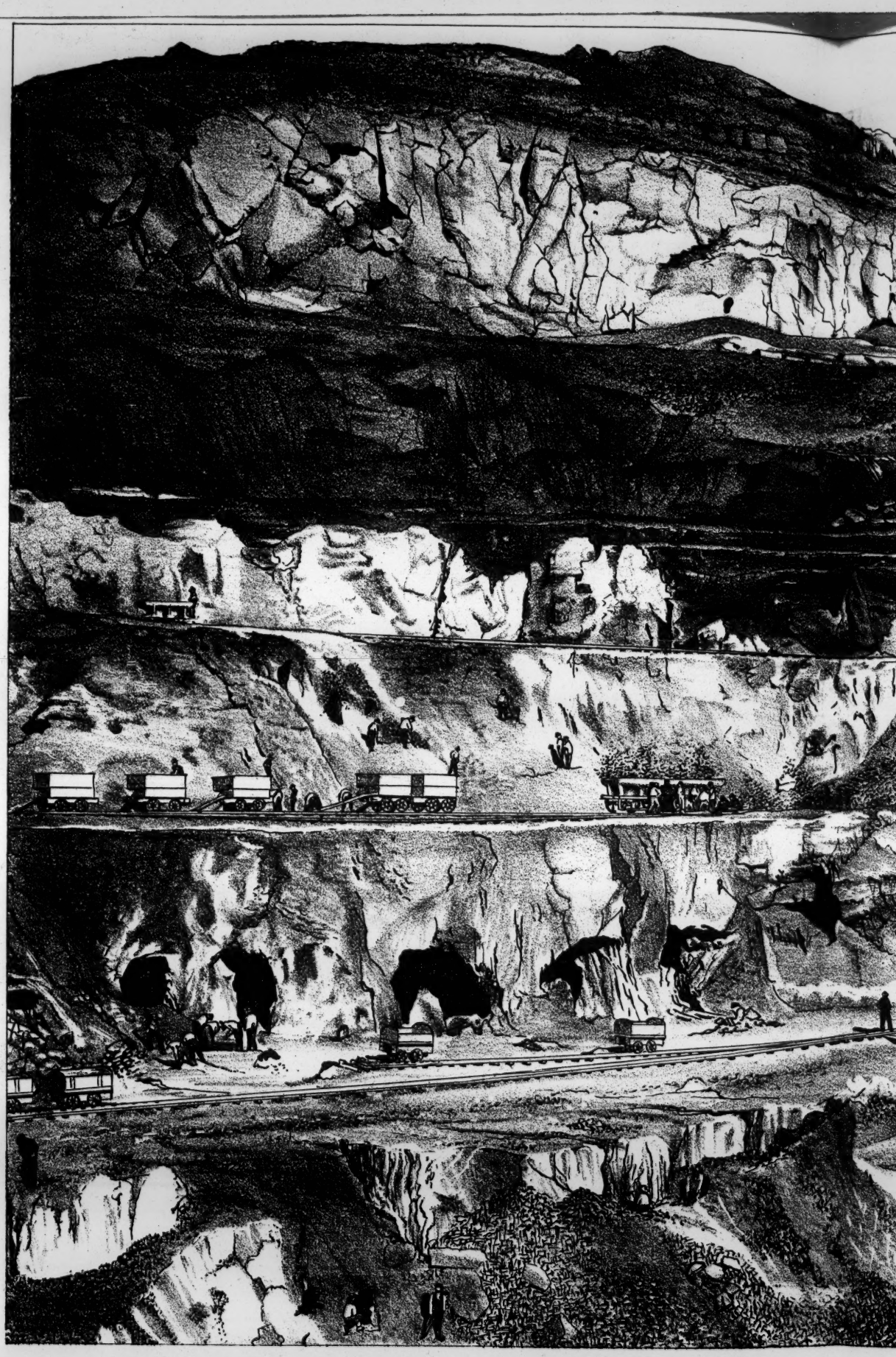
The open cutting is worked in stages, or steps, each connected by tunnels with a railway by which the richer ores, intended for exportation, are taken to the main line, by which they are sent to the port of shipment at Huelva; while the poorer ores, destined for local treatment, are taken to the calcination grounds. The total length of these local railways, which are of the same gauge as the main line and are worked by locomotive power, is 17 miles.

The illustration, Plate IV., from a photograph of a portion of the Rio Tinto cutting, looking north, shows some of the Roman and early Spanish workings which have been cut into during the progress of the work.

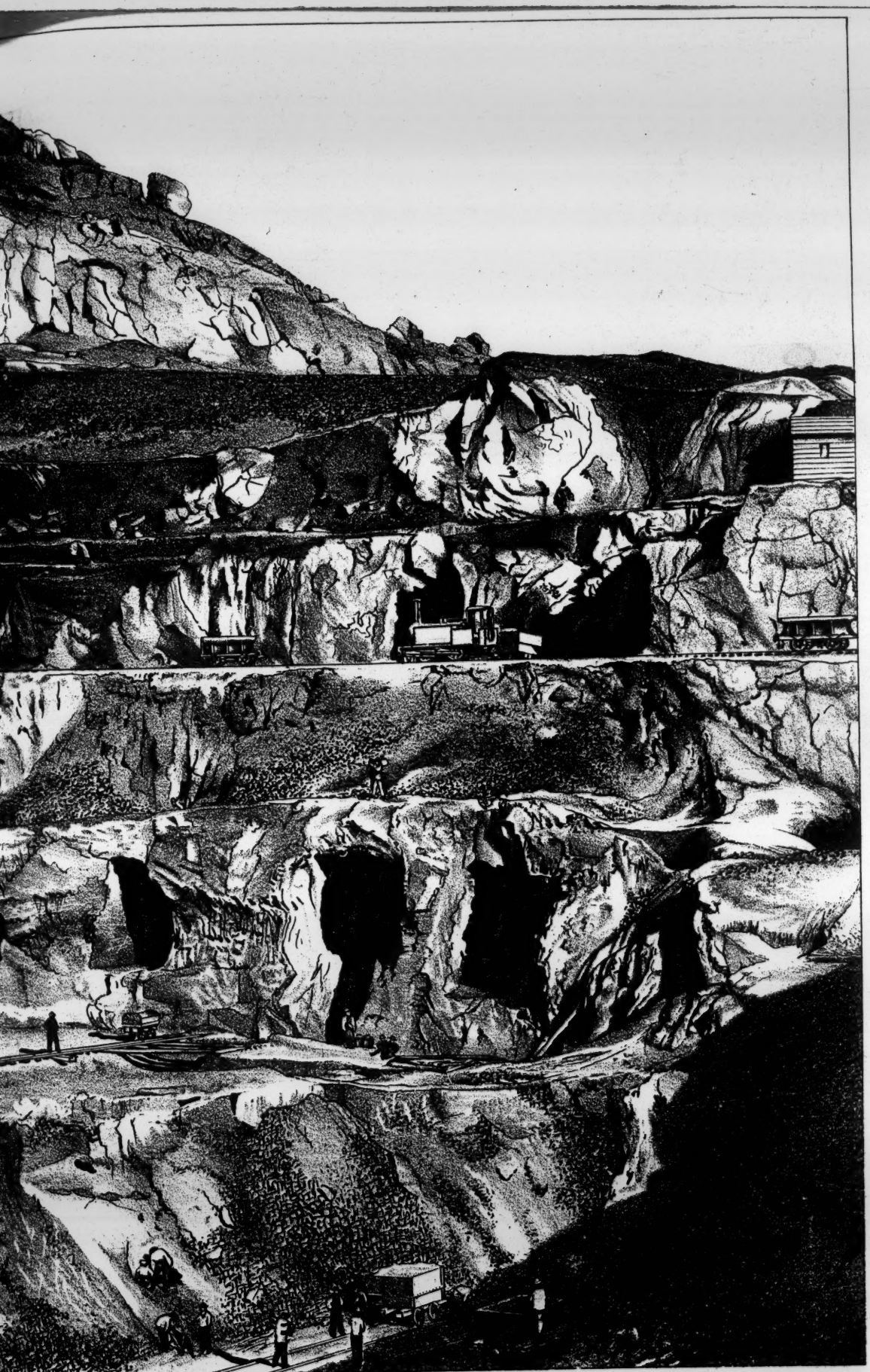
On arriving on the calcination grounds the ores are built into heaps, or *teleras*, of the form of a beehive, each containing from 100 to 500 tons; these are lighted at bottom, either by the help of brushwood or of a little coal, and the sulphur of the pyrites, taking fire, a slow combustion is continued during several months.

At the expiration of some eight or nine months the teleras have generally burnt out, and a large proportion of the copper has been converted into cupric sulphate, which is a salt soluble in water.

The ore is now removed to large tanks, each some 60 feet long, 16 feet in width, and 3 feet in depth, where it is lixiviated by successive additions of water which, after dissolving out the salts of copper, is run through an extensive labyrinth of tanks in which pig iron is regularly stacked in hollow piles. Here



OPEN CUTTING AT RIO TINT



W.Griggs Lith.

TINTO LOOKING NORTH.

the sulphuric acid of the sulphate of copper transfers itself to the iron with formation of soluble ferrous sulphate, while the copper, in a metallic granular state, but contaminated with the carbon and some other impurities of the pig iron, is deposited. In order to collect this precipitated copper, the liquors are diverted in succession from the various tanks forming portions of the arrangement for precipitation, the liquid drawn off, and the iron removed from one end of the tank, any adhering copper being brushed off. The copper in the bottom of the tank is now collected, and the cleaned iron replaced with an addition of fresh pig; the operation being continued with the next stack in succession, until the whole of the pig iron has been cleaned and freshly stacked, and nearly the whole of the copper taken out. This precipitated copper, when washed, freed from fragments of iron, and calcined, contains about 75 per cent. of metallic copper; it is then bagged and forwarded to England to be refined and melted into ingots, as the high price of fuel in Spain renders it inexpedient to complete its metallurgical treatment in that country.

On account of the very limited rainfall which occurs in this portion of the Spanish peninsula, the supply of water requisite for these operations is exceedingly difficult to obtain, and it has consequently been found necessary to dam two large valleys by dykes, thus making reservoirs, of which one will be provided with powerful pumping machinery. The first of these tanks, which has for some time been in operation, is capable of containing 70,620,000 gallons of water, while the other, now in course of construction, will have a capacity of over 100,000,000 gallons.

All the engineering work connected with this vast undertaking has been skilfully designed and efficiently carried out by the resident manager, Mr. M. W. Carr, whose arrangements are already so far advanced that the production of copper from the extraction works alone already exceeds 150 tons per week.

The average number of work-people now employed upon the mines, railway, and calcination grounds of the Rio Tinto Company, may be taken at about 5,000, but upon the completion of works in connection with the water supply, this number will be reduced, while the output of copper will be largely increased.

The ores obtained from the different mines very closely resemble one another in composition, but, as already stated, the richer, "selected," ores only are exported for the use of the alkali manufacturer, the poorer varieties being retained for local treatment.

The following analysis, by Mr. F. Claudet, of pyrites from the San Domingos mine, may be taken as an average sample of good exported ore:—

Sulphur	49·00
Arsenic	·47
Iron	43·55
Copper	3·20
Zinc	·35
Cobalt	trace
Silver	trace
Lead	·93
Lime	·10
Insoluble residue	·63
Water	·70
Oxygen and loss	1·07
	100·00

When this ore is burnt for the production of sulphuric acid, the resulting cinder may be taken to have, approximately, the following composition :—

Sulphur	3·76
Arsenic	·25
Iron	58·25 = 83 °/₀ Fe_2O_3
Copper	4·14
Zinc	·37
Cobalt	trace
Silver	trace
Lead	1·14
Lime	·25
Insoluble residue	1·06
Water	3·85
Oxygen and loss	26·93
	100·00

The amount of silver in burnt ore varies from 15 or 18 dwt. per ton in the San Domingos cinders, to 1oz. 15dwt. in that from Rio Tinto pyrites. A few grains of gold per ton are also contained in all Spanish and Portuguese ores.

In order to obtain the copper by the wet process of extraction, the burnt ore is first finely ground and sifted, and subsequently roasted with about 12 per cent. of common salt until, by the oxidation of the metallic sulphides, a portion of the salt is converted into sulphate of soda, while the copper becomes transformed into a soluble chloride. The copper salt is subsequently removed by repeated washings with hot water, and the copper precipitated in the metallic state by scrap iron.

After the removal of the copper by solution the residual "purple ore" or "blue billy" is thrown out of the washing vats, which are again filled with freshly roasted ore, and the operation proceeds as before. The purple ore so obtained contains 96 per cent. of peroxide of iron, equal to 67 per cent. of metallic iron, and as it contains no phosphorus, and only traces of sulphur, it is largely employed in the blast-furnace as a source of iron, as well as for the lining of puddling furnaces.

The silver contained in these ores was for some time lost, but by a process invented by Mr. Claudet, it is now, to a very large extent, recovered, and a portion of the gold is at the same time obtained.

Nearly the whole of the precious metals present in the burnt ores is contained in the first three washings from the roasted cinder, and, after ascertaining, by means of an assay, the proportion of silver present, a sufficient amount of a standardised solution of iodide of potassium is added. This causes the precipitation of the silver in the form of an insoluble iodide of that metal. The whole is then allowed to stand for forty-eight hours, in order to allow the precipitate to settle, and the supernatant copper liquor is afterwards run off to the tanks containing iron for precipitation.

The argentiferous precipitate, after having been duly washed, is decomposed by boiling with metallic zinc; by this treatment, on the one hand, a mixture of metallic silver with sundry impurities and a notable amount of gold is obtained, while on the other a solution of iodide of zinc is produced, which is standardised and employed in subsequent operations. In this way the valuable substance iodine is used over several times with only a slight loss upon each operation. During the year 1877, 124,500oz. of silver, and 320oz. of gold were recovered by Claudet's process from liquors resulting from the treatment of Spanish and Portuguese pyrites.

The chief production of Spanish and Portuguese pyrites is from the mines of Tharsis, Rio Tinto, and San Domingos, but small quantities of this mineral are likewise obtained from sundry other localities. Of the total annual export from these countries about 600,000 tons, representing 280,000 tons of sulphur, are consumed in this country. In addition to this 54,000 tons of sulphur in the form of brimstone were imported in 1877; thus bringing the grand total of our consumption for that year up to 334,000 tons. A portion of the sulphur imported in the form of brimstone is employed for the preparation of gunpowder and for various other purposes, but a large proportion of it, as well as nearly the whole of that existing in the form of pyrites, is consumed either by alkali makers or by artificial manure manufacturers.

The amount of common salt decomposed by sulphuric acid during the year 1877 was 578,201 tons, while from the resulting sulphate of soda were prepared 223,776 tons of dry carbonate of soda, 169,769 tons of crystallised carbonate of soda, 74,663 tons of caustic soda, and 12,109 tons of bicarbonate of soda. In addition to this 105,529 tons of bleaching powder were prepared from hydrochloric acid resulting from the action of oil of vitriol upon common salt.

The above are large amounts, and represent a money value of about 6,500,000*l.*, but in addition to sulphur these mines annually send 28,000 tons of copper, of the value of 1,680,000*l.*, into the markets of the United Kingdom; this is above nine times the amount produced in Cornwall in 1877, and six and a half times more than the aggregate production of the United Kingdom during the same year. The sulphur supply of France is chiefly derived from pyrites mines situated near Lyons, while a large proportion of the pyrites consumed in Germany is obtained from Westphalia. The pyrites employed in those countries contains no copper.

EXPLANATION OF PLATES III. & IV.

PLATE III. Plan and elevation of an ancient Roman drainage-wheel found at the San Domingos Mine, Portugal. This wheel, which is constructed entirely of wood, somewhat resembles an ordinary water-wheel in which the buckets have been reversed. As, however, both its internal and external rings are continuous, the water, which enters the buckets by the apertures in the sides while they are passing through the trough at the bottom, can only escape through these same openings when raised to the height of the launders, *a*, and, flowing out on either side, is conveyed to another trough, in which is placed a second wheel of similar construction.

It is evident that by the use of a series of such contrivances, placed one above another and all turned at the same time, water can be raised from a considerable depth.

PLATE IV. This plate, engraved from a photograph, shows the position of the great open cutting at Rio Tinto looking north. The old workings, which have been cut into during the progress of the excavation, are partly of Roman origin, and in part made by the Spaniards.

THE EVOLUTION OF THE ELEMENTS.

By M. M. PATTISON MUIR, M.A.

THE paper which Mr. Lockyer recently read before the Royal Society suggests many interesting problems to the chemist, but at the same time it awakens within him a feeling bordering upon despair. Are we not to be allowed to retain our belief that the elements are indeed what their name claims them to be? If we allow the physicist to take our elements from us, what possession of ours can we deem secure from his attack?

But, whatever be the result, we must examine the facts, and endeavour to arrive at a just conclusion concerning the nature of the so-called elementary bodies.

It has long been known that the elements may be arranged in certain families or groups, between the members of each of which many remarkable relationships are apparent. Not unfrequently, the numbers expressing the relative amounts of different elements, being members of the same group, which combine together in the formation of compounds, are found to bear certain simple relations to one another. Thus in the family of the halogens the combining weight of bromine is expressed by a number which is almost exactly the mean of the combining weights of chlorine and iodine.

Reasoning on such facts as this, Prout, many years ago, propounded the hypothesis that the elements are all compounds of one kind of matter; that is, that the smallest particles of each element which exhibit the characteristic properties of the element are composed of varying quantities of one and the same primary form of matter. This primary form of matter Prout supposed to be hydrogen. This hypothesis required that the weights of the smallest individual particles of each element should be whole multiples of that of the smallest individual particles of hydrogen. But exact investigation, more especially the investigations of Stas, showed that this was not the case. Stas obtained fractional numbers expressive of the combining weights of those elements which he investigated. It is, however, worthy of remark that the most recent researches of Dumas have shown that Stas overlooked a source of error in his other-

wise wonderfully laborious and refined experimental work; and that a number which is an integer multiple of the combining weight of hydrogen is obtained by Dumas as the combining weight of one of those elements to which Stas assigned a fractional number. Analogies may be traced between the properties, more especially between certain physical constants, of groups of elements, and the properties of substances which are certainly compounds, in varying proportions, of two distinct elements. Further it is known that one and the same element may exist under what are technically termed allotropic modifications; that is to say, that *a* substance which we are unable to decompose into any simpler form of matter may nevertheless exhibit, under varying conditions, different physical, and to a certain extent also different chemical, properties.

Such analogies, details of which I cannot here recapitulate, give a certain degree of plausibility to the theory that the so-called elements are really non-elementary bodies. But such analogies, it may be urged, are shadowy and vague at the best. Twist it how you may, the *fact* remains that we *can* decompose those bodies which we call compounds, and that we *cannot* decompose those bodies which we call elements. No one—triumphantly remarks the orthodox chemist—no one has yet succeeded in decomposing an element. Are you sure of this? Were one to decompose sodium to-morrow, it is by no means certain that one could recognise the products of the decomposition. The ordinary conditions of temperature and pressure would be entirely altered when one succeeded in decomposing sodium; and under these altered conditions no small difficulty would be encountered in endeavouring to determine the fact of decomposition. We may have decomposed the elements, and not have discovered our own success. New problems require new methods for their solution. Anyone who should attempt the study of what I may call the Elementary Elements with the ordinary appliances of the laboratory, would certainly be doomed to failure.

Mr. Lockyer has attempted to solve the problem presented by the elements by combining a new series of experiments with a new method of observation. He has observed the phenomena which occur when certain elements are exposed to the action of intense heat by the aid of perhaps the only instrument at present known, which is capable of giving a satisfactory account of such phenomena—the spectroscope.

The paper in which Mr. Lockyer propounds his views of the nature of the elements is entitled, "Discussion of the working Hypothesis that the so-called Elements are Compound Bodies." At the very outset, therefore, the author is careful to abstain from saying that he has succeeded in decomposing the elements.

Each (undoubtedly) compound body presents us with a characteristic spectrum. The spectra of compounds are characterised by channeled bands and fluted spaces; the spectra of elements (so-called), on the other hand, are characterised by lines, and are comparatively free from bands and channeled spaces.

If calcium chloride be volatilised in a flame the temperature of which is insufficient to cause decomposition of the chloride, no lines characteristic of the metal calcium are seen in the spectrum; if the temperature be increased the calcium lines make their appearance, while the bands due to the chloride fade away, and at last disappear altogether.

The behaviour of calcium chloride may be regarded as typical of that of a compound body when subjected to gradually increasing temperature.

If an element A, known to be mixed with relatively small quantities of another element B, be volatilised, the spectrum of the flame exhibits the characteristic lines of that element (A) which is present in larger quantity, and, added to these, the lines of the impurity (B); the greater the amount of B the greater being the prominence of its lines in the spectrum.

The two cases—viz. that of a compound undergoing decomposition as the temperature increases, and that of a mixture of two elements—may thus be partially differentiated by means of the spectroscope.

Suppose that a compound substance is volatilised at a temperature at which dissociation just begins, and suppose that four lines ($\alpha, \beta, \gamma, \delta$) are apparent in the spectrum; now let the temperature be increased, dissociation proceeds, the line δ disappears, γ thins out, while β becomes prominent; let the temperature be further increased, a process analogous to that already sketched proceeds, until the line α alone remains prominently shown. On reversing the process—that is, on passing from higher to lower temperatures—the spectrum gradually becomes more complex until the original condition is reached. It is, however, to be noted that the line α which is the sole strongly-marked line at high temperatures, does not disappear, but only becomes thinner and less marked at lower temperatures.

Now if we suppose the substance exhibiting the original spectrum (α, β, γ, δ) to be a so-called element, and further if we suppose this element to undergo decomposition as the temperature increases, we should have just such a series of spectra as that described.

In the paper already cited, Mr. Lockyer gives a diagram of certain of the lines in the spectrum of calcium as seen at temperatures varying from that of the Bunsen lamp to that of the star Sirius; and this spectrum he pronounces to be just what

we should expect to find on the supposition that the element has undergone decomposition at the high temperatures of the sun and Sirius.

By a comparison of the lines of calcium as seen in the spectra of Sirius, *a* Aquilæ, and the sun, Mr. Lockyer finds that that line which is all important in the spectrum of the first-named star has become much less marked in the spectrum of the second; in which, however, a new broad, well-marked line has suddenly, as it were, started into being. The characteristic line of Sirius, and that of *a* Aquilæ, he regards as probably indicative of the presence in the former of one, and in the latter of another, of those simpler forms of matter into which, on his theory, calcium is at these exalted temperatures decomposed.

Calcium, as we know it, is thus a product of comparatively low temperature. If the line spectrum of calcium obtained at the temperature of the electric arc be indeed caused by the vibrations of the true atoms—as distinguished from the molecules—of that metal, then the evidence, granting it to be trustworthy in all respects, most probably points to a splitting up of calcium in the atmosphere of Sirius with the production of a form of matter altogether different from anything known to us on this earth.

But it may be urged that even at what are *to us* exceedingly high temperatures, the calcium molecules are not decomposed, and that the line of calcium which is so marked in Sirius and other hot stars is probably due to the vibration of the calcium atoms into which the molecules *are* resolved at these extremely high *stellar* temperatures. Indeed Mr. Lockyer has himself ("Nature," x. 90) stated facts which are not inconsistent with this view.

Now, if this theory be adopted, it is evident that the answer to be given to the query, Are the elements elementary? depends upon the meaning which is assigned to the term "element." If this word be used to designate a substance from which no forms of matter exhibiting properties different from those of the original forms can be obtained, then the elements are, by our theory, not elementary. But if to "element" we give a more exact meaning, and define it as substance, the molecules of which are composed of two or more similar atoms, then the elements are, by this theory, truly elementary.

The controversy regarding the nature of the chemical elements turns largely on the meaning which is given to the term "element."

If we are to regard the effect of greatly exalted temperatures upon the molecules of the elements as consisting in a decomposition of these molecules into their (similar) atoms, we must be prepared to bring forward evidence in support of the pro-

positions—(1) that the properties exhibited by the atoms of elementary bodies are markedly different from those exhibited by the molecules of the same bodies; (2) that the molecules of the elements may remain undissociated into their constituent atoms even at very high temperatures, in other words, that molecules are very stable systems; but (3) that those molecules are decomposable; and (4) that changes in molecular weights may occur among elements or compounds, which changes are correlated with considerable modifications of the properties of those elements or compounds.

I cannot but think that chemists have for many years had evidence before them which might warrant the statement that, *in a certain sense*, the elements are really compound bodies.

The molecule is defined as the smallest part of a substance which exhibits those properties which are characteristic of that substance; if the molecule be subdivided, a substance (or substances) with new properties is produced. We have very distinct evidence in proof of the statement that when two gaseous elements—say chlorine and hydrogen—combine, the combination takes place between the atoms of these elements, which atoms are themselves first of all liberated from the state of mutual combination in which they existed in the molecules of the elements. The act of combination is preceded by an act of decomposition. We call the product of the combination a compound, because its molecule is composed of different atoms; we call the bodies which have undergone decomposition elements, because their molecules are composed of similar atoms.

But we are unable to isolate and examine those atoms of which the elementary molecules are composed. We believe that at the moment of the liberation of an element from a compound that element exists in the atomic condition; we know that at the moment of liberation many gaseous elements are capable of performing actions which they are incapable of performing under ordinary conditions.

We may probably say that in the production of hydrogen from water by the action of the electric current we have three distinct chemical changes occurring: viz. decomposition of the water molecules with the production of atoms of hydrogen and oxygen; combination of the hydrogen atoms with the production of what is known to us as hydrogen; and combination of the oxygen atoms with production of what is known to us as oxygen. In the second and third changes the products of each change are removed from the sphere of action; the change proceeds with great rapidity. We cannot arrest the series of changes at the close of the first; but we know that the introduction of certain substances

sometimes suffices to prevent the second or third change from occurring; and, in place thereof, we are presented with a new chemical change traceable to the action of the dissociated hydrogen or oxygen atoms upon the new substance introduced. Now we call the atoms of the two elements which, by their union, produce water, atoms of hydrogen and oxygen; and, in a sense, this is correct. These atoms, by their union together, produce hydrogen and oxygen respectively; they are therefore atoms of hydrogen and oxygen. But we know very little concerning the exact nature of these atoms *per se*, and all we do know points unmistakably to the conclusion that the properties of these atoms are very different from those which are characteristic of the bodies known to us as hydrogen and oxygen.

I think it would scarcely be too much to say that the whole edifice of modern chemical theory rests upon the hypothesis—may we not say upon the fact?—that the properties of the elementary atoms are markedly different from the properties of the elementary molecules. But, at the same time, facts do not allow us to regard the elementary molecules as composed of atoms of two or more kinds of matter; in other words, all the atoms of hydrogen are certainly possessed of the same properties. The hydrogen molecule may then be regarded as A + A, not A + B. We know the properties of the body A + A; we also know the properties of many other bodies into the composition of which A enters (A + C, A + D, A + E, &c., &c.); but we know very little regarding the properties of A, or B, or C, &c., as distinct from the properties of the compounds of those bodies. We can, it is true, trace modifications in the properties of a compound brought about by the entrance of A, or B, or C into that compound; but we are unable to isolate A, or B, or C, and study its properties when in the free state.

The decomposition of an elementary molecule into its component atoms would thus be a phenomenon not altogether analogous to the decomposition of a compound molecule into its components.

Until recent years we have been content to decide the question of the decomposition of a given substance in a certain reaction by examining the supposed products of decomposition by the ordinary physical or chemical tests. Chemists found no difficulty in distinguishing sodium from soda, iron from rust, mercury from its compound with oxygen; but now we learn that more searching examination must be made before an answer can be given to the question, Are the elements themselves capable of decomposition?

If our elements are non-elementary, they are at any rate much more stable, they are in a sense more definitely marked chemical entities, than our compounds.

The evidence in proof of the second and third propositions laid down on p. 129—viz. that molecules are very stable systems, but that they are nevertheless decomposable—may be said to be furnished by the whole science of Natural Philosophy.

Physical research has determined series of constants for the elementary and compound molecules; it has shown us how stable these systems are, what definite and clearly marked properties may be predicated of each of them, and how the properties of masses of matter are to be traced to the properties of the molecules of which these masses are built up.

Chemistry, on the other hand, teaches, without doubt or hesitation, that, stable as those molecules are, they are nevertheless decomposed when acted upon by chemical force. To enumerate the leading instances of such decomposition would be to write a treatise on Descriptive Chemistry.

The fourth proposition—viz. that changes may occur in the molecular weights of elements or compounds, which changes are correlated with considerable modifications of the properties of those elements or compounds—demands illustration in some detail.

Apart from the evidence furnished by chemistry in support of this proposition, we know of facts which can scarce find an explanation if this statement be denied. Schuster's recent work on the Spectra of Oxygen obliges us to regard the existence of varying molecular groupings of that element as extremely probable, and tends to discredit the idea that mutual interferences among the vibrations of the same molecules may be a *vera causa* of the totally different spectra of oxygen which he has observed. ("Nature," xviii. 269.) Certain of the changes observed by Dr. Schuster to occur in the spectrum of oxygen are most abrupt and complete, and seem only to find an explanation in the hypothesis that distinct molecular groupings of that element exist even at high temperatures.

But let us look at the chemical evidence in support of our fourth proposition. I suppose everyone regards oxygen and ozone as forms of one and the same elementary body. The marked differences in the behaviour of these bodies are traceable to the fact that the molecule of the latter contains half as many more atoms as the molecule of the former. The molecular weights of oxygen and ozone stand to one another in the proportion of 2 to 3; their molecules are composed of similar atoms, nevertheless the properties of these molecules are by no means identical. Again, the molecular weight of sulphur vapour at temperatures a little above the boiling point of that substance is three times as great as the molecular weight of the same element at considerably higher temperatures. Little is known of the properties of the molecules of sulphur as they exist at either of these temper-

atures; but, from the very marked differences in the properties of this substance when in the solid state, it seems probable that solid sulphur, like gaseous sulphur, is capable of passing from one molecular grouping into another. It may be remarked, in passing, that sulphur yields a line spectrum only at very high temperatures. Phosphorus and arsenic, again, present us with instances of probable changes in molecular weights correlated with decided changes in general chemical and physical properties. Indeed, the whole series of facts grouped under the term *Allotropy* finds its only rational explanation on the assumption that the molecules of the elementary bodies may exist in various more or less complex groupings.

When we turn to compounds we find numerous instances of the same kind. Are not the so-called polymeric compounds of organic chemistry instances of the great change which is brought about in the properties of a compound by doubling or tripling the weight of its molecule?

An oxide of nitrogen represented by the formula $N_2 O_4$ exists; when this compound is heated its physical properties are altered. From a deep-red-coloured gas it is converted into a colourless gas; but the elementary composition of each gas is the same, only the molecular weight of the colourless compound is represented by the formula NO_2. In a sense these two bodies are the same; in another and a truer sense they are different. Spectroscopically considered, there is a marked difference between these compounds.

If the facts which Mr. Lockyer has amassed concerning changes in the spectra of the elements be considered from a chemical standpoint, it seems to me that they are in keeping with other phenomena of a more purely chemical nature, and that both series of phenomena point to the compound nature of the elements, in the sense that the molecules of these bodies are *composed of* particles (atoms) exhibiting properties different from those of the elements themselves, but at the same time that the atoms of any one element all exhibit the same properties.

Whether these elementary atoms are or are not themselves capable of undergoing decomposition must remain an open question.

I do not enter into the question of the meaning of those short lines which Mr. Lockyer states are to be found occurring in the spectra of different elements after eliminating all impurities. Until the methods adopted for eliminating impurities are published in detail, and until we are possessed of exact information with regard to the effect of very small quantities of impurities in modifying the elementary spectra, it seems to me preferable to abstain from framing hypotheses which may eventually be found not to rest on any sure foundation of fact.

Mr. Lockyer's work certainly furnishes us with new proofs of the existence of varying molecular groupings for one and the same element, and of the fact that these groupings become simpler as temperature is increased; but I do not think that we are as yet compelled to believe that essentially new kinds of matter—that is, matter, the molecules of which are composed of atoms other than those composing the molecules of the original matter with which we started—are produced, even at extremely high temperatures. We may, perhaps, regard the molecules of our elements when in the gaseous state at moderate temperatures as consisting each of distinct atoms; as temperature increases some of these molecules are partially decomposed, but without the production of new atoms, until, at extremely high temperatures, the greater portion of the mass of matter present exists in the true atomic condition. It may be that at yet higher temperatures, or under altogether different conditions, these atoms would themselves be decomposed, and that this process would proceed, until finally the primary atom, of which all *our* elementary atoms are but compounds, would be reached.

On this view the formation of so-called elementary atoms, and again of so-called elementary molecules, would mark resting-places in the process of evolution, points of stable equilibrium in the cycle of development. But this is merely hypothetical.

M. M. Pattison Muir.

THE STRUCTURE AND ORIGIN OF LIMESTONES.*

By H. C. SORBY, F.R.S., President of the Geological Society.

IN his Anniversary Address, delivered at the annual meeting of the Geological Society in February, the President, Mr. H. C. Sorby, F.R.S., departed somewhat from the ordinary form of Presidential addresses, and laid before the Fellows the result of some laborious original researches which seem to open up a new field of geological investigation, or at all events to suggest the application of a perfectly new method of research to the solution of questions which have certainly already, to a limited extent, attracted the attention of geologists. He devoted his address to the consideration of the structure and origin of limestones, relying mainly on his own observations, but incorporating general facts derived from other sources.

Since, in order to properly understand the nature of the various constituent fragments of which many limestones are composed, it is necessary to know the organic and mineral constitution of the different living calcareous organisms, this question was first considered *from a somewhat novel point of view*, and very great attention was paid to their optical characters, by using a new form of apparatus, specially designed for such inquiries. The conclusion arrived at was that the microscopical structure depends on both organic and mineral growth, the influence of the one or the other varying greatly in different organisms. Much attention was also directed to their mineral constitution, so as to determine whether the carbonate of lime exists in the form of calcite or aragonite. The results are in some cases very curious and interesting, even from a biological point of view. Certain large natural groups are composed of calcite, and others of aragonite, whilst others are made up of well-marked layers of the two minerals. In a few cases they occur too intimately mixed to be separated.

* We need hardly apologise to our readers for laying before them this abstract of a most interesting and important memoir. For all but the first paragraph we are indebted to the kindness of Mr. Sorby.

A knowledge of the true mineral constitution is of the highest importance in studying the changes which occur in fossils and in the investigation of limestones, since the final results depend almost exclusively on the original mineral constitution, and vary very greatly, according as the organism is calcite or aragonite. This is due to the fact that calcite is in a state of stable equilibrium, and cannot be changed to aragonite; whereas aragonite is relatively in a state of unstable equilibrium, can be changed to calcite, and usually is so changed, in limestone rocks. This circumstance has given rise to a complete difference in the state of preservation of many fossils. When they were originally calcite they may have been further consolidated, although retaining their original structure and optical properties; whereas when they were aragonite they have sometimes been completely removed by solution, and in other cases are changed into a mass of crystals of calcite, and have lost their original microscopical and optical characters. The general structure of various recent and fossil organisms was then considered, with special reference to the identification of the minute fragments occurring in limestone rocks. When they were originally composed of calcite, and have retained their original characters, there is usually little difficulty in identifying them more or less definitely, according to their particular nature, so as to be able to form a good opinion as to the constitution of each particular limestone.

The various facts connected with the disintegration of shells, corals, and other organisms are of great importance in studying limestones, since without an adequate knowledge of the manner in which they decay and fall to pieces very inaccurate conclusions might be formed respecting the origin of calcareous deposits. The results mainly depend on original structure, and on whether they are composed of calcite or aragonite.

The next questions considered were the manner in which the external form of minute fragments is preserved in limestone, and the various chemical changes occurring after deposition or consolidation. When their structure is preserved there is no difficulty in recognising the fragments; but when they have become almost equally crystalline with the surrounding material, their outline is shown by a thin layer of dirt, or by a zone of finer crystalline texture. After deposition and consolidation certain changes have often occurred, the chief of which are the replacement of more or less of the lime by magnesia or by iron compounds. After having thus established the general principles necessary for their accurate study, Mr. Sorby entered on a description of our various English limestones, in descending order.

The main object was to ascertain, as far as possible, the exact

nature of the material from which each particular rock was derived. Some beds are mainly composed of definite fragments, so as to be analogous to sands, and then the true nature of the various organisms from which the fragments are derived can be ascertained, provided they were originally calcite; whereas, if they were originally aragonite and their structure is lost, very often all that can be said is that they were portions of aragonite shells or corals. Many associated beds are or were composed of fine granules, and analogous to clays. In many cases these have in all probability been derived to a great extent from aragonite organisms decayed down into small granules of calcite, and it is quite impossible to further identify the material.

The structure and origin of oolitic grains were dwelt upon at some length. Usually they are evidence of true chemical deposition, since they are of simple crystalline growth, quite independent of living organisms. They occur of three distinct types, viz.: those composed of aragonite, like the Carlsbad *Sprudelstein*, having a concentric structure without any radii, giving rise with polarized light to a black cross optically positive; those which are composed of calcite, having a radiate structure, and giving rise to a negative black cross, which are the predominant and characteristic type of our oolitic rocks; and those which have recrystallized since their original formation, which in all probability were originally aragonite, subsequently changed into calcite.

After describing the chief points of interest connected with the leading limestone rocks of our country, Mr. Sorby collected together the results into two tables, the more condensed of which may here be given:—

Name of rocks.	Chief constituent fragments, &c., in descending order.
Cretaceous	Shell prisms, Foraminifera, Coccoliths.
Wealden	Freshwater aragonite Mollusca, Entomostraca.
Jurassic	Chemical deposits, aragonite Mollusca and Corals, Brachiopoda, Echinoderms, shell prisms.
Permian	Original structure lost by dolomitization.
Carboniferous	Encrinites, Brachiopoda, Foraminifera, Corals, and Polyzoa.
Devonian	Encrinites, Corals, and allied organisms.
Silurian	Encrinites, Corals and Polyzoa, Brachiopoda, Trilobites.
Metamorphic.	Original structure lost, quartz and silicates formed *in situ*.

He concluded as follows:—

"On examining these tables, especially the more detailed one, it will be seen how remarkably and characteristically our limestones differ from one another. There would usually be little difficulty in deciding the general age of any characteristic, somewhat coarse-grained, specimen. Though this difference must to a great extent have depended on the nature of the

organisms living at each period, yet it must also have depended on the accompanying mechanical and chemical conditions of the water in which the deposits were formed. The structure of each rock was, therefore, dependent on two most important circumstances, and we need not be surprised to find the results so varied and characteristic. Passing upwards from the earlier rocks, we may often trace a gradual change, broken here and there by a complete contrast, which is in perfect agreement with results arrived at from a totally different class of facts. On the whole, this is perhaps the most important conclusion that we can at present draw from the subject before us. Possibly further research may teach us much more, since I am quite sure that much remains to be learned. In fact, long as I have studied these questions, and long as this address has been, I know quite enough of the facts to be convinced that it is only a sort of first attempt and rough sketch of a very wide and complex subject."

THE SUPPOSED NEW CRATER ON THE MOON.

By E. Neison, F.R.A.S.

NEAR the centre of the surface of the lunar hemisphere which is turned towards the earth, there is an open region which is called by astronomers the Mare Vaporum. It is a tolerably level plain, with a grey coloured surface, broken by some small hills and craters, and traversed by a number of low, gently sloping ridges. It is bordered on all sides by elevated hill lands, plateaux, or lofty ridges. This region is from its situation so favourably placed for observation that all its features can be observed and its appearance delineated with great facility.

In the southern portion of this grey plain, the Mare Vaporum, there is a small crater some five miles in diameter, which was named Hyginus by Riccioli, the founder of the present system of lunar nomenclature. The crater lies in the centre of a level portion of the Mare Vaporum separated from the rest by some broad valleys and ridges of a dark grey colour. Running right across the plain a very remarkable formation was discovered by Schröter, the celebrated Hanoverian astronomer and the rival of Sir William Herschel. This formation, which is termed a cleft or rill, resembles a great dry canal or gorge, or still more what is in America termed a Cañon. It is a sharply marked gorge or ravine over a thousand feet deep, and about three-quarters of a mile broad, with steeply falling sides. It extends for nearly 150 miles right across the plain, bursting through all obstacles, and ending on the great grey plain called the Mare Tranquillitatis. This rill was the first of these extraordinary formations which was discovered, so that its discovery excited much astonishment and led to the entire region being examined with great care. Since then many similar though more minute formations have been discovered, and in particular a most intricate system of these rills was discovered by Beer and Mädler in the open plain to the south of Hyginus. In consequence of these discoveries this portion of the lunar surface has been most

attentively studied, and its appearance has been repeatedly drawn, and the whole region mapped with especial care. Consequently it is a portion of the surface of the moon whose appearance and configuration are known with much exactitude.

For many years it has been the opinion of the great majority of astronomers that no apparent changes of any magnitude were now taking place on the surface of the moon. Nor is it difficult to understand how this opinion has become generally prevalent. It originated in a summary by the celebrated selenographer Mädler of the differences in the constitution of the moon and earth, in which he forcibly pointed out the impossibility of the view held by the earlier astronomers, which was that the moon might be a mere copy of the earth. In these remarks Mädler indicated that, compared with the earth, with its large oceans, abundant vegetation and numerous fauna, the moon would be a lifeless desert. In a condensed and far less qualified form these remarks were copied into all the text-books of astronomy, and constituted the basis of the views commonly held by astronomers.

They gradually came to look upon the moon as an arid lifeless desert, an extinct volcano. Nor is the real condition of the moon, when seen through a telescope, such as to remove these views. "Its cold, still, apparently unchangeable surface, so utterly unlike what the earth might be supposed to appear as seen from the moon, convinces the casual observer that the world he then sees is utterly unlike the world he knows. He looks for immense cloud masses floating in a dense atmosphere; for wave-tossed seas and winding broad rivers, and there are none; searches for luxuriant forests and green prairies, and they are absent. This is enough, and he retires from further contemplation of the 'airless, waterless, lifeless, volcanic desert' of the text-books."

It is, however, a noteworthy fact that this is not the view entertained by those who have devoted much time to the study of the condition of the lunar surface. These astronomers believe that they have found a number of facts which in their opinion indicate that great physical changes are slowly taking place on the surface of the moon. Schröter, Lohrmann, Gruithuisen, Mädler, Schmidt, five most famous selenographers, men who have devoted many years to observing the moon, have all pointed out appearances which they had observed, and which they believed indicated instances of real change taking place on the lunar surface.

Yet the great body of astronomers still retained their opinion, although they had not devoted any special attention to this question; they contended that no change had been proved to have occurred, and refused to alter their opinion that no change

was possible until some change had been proved to have taken place.

Within the last few years some important instances of probable lunar change have been made known. Thus the crater Liuné described by Lohrmann, Mädler, and Schmidt as six or seven miles in diameter and very deep, has now quite disappeared, leaving only a white spot surrounding a small crater of scarcely one-tenth the former area. Other instances have also been made known of the disappearance of craters which had been described by the earlier selenographers, and of the appearance of other craters in places where no crater had been seen before. In none of these cases is the evidence perfectly decisive; there is in all cases room left open for doubt, and consequently they have been waived aside by astronomers in general.

Several years ago it was pointed out that to obtain a decisive instance of a real physical change of this nature, it would be essential for a crater of some size to make its appearance in or to disappear from one of some three or four regions in the moon which had been thoroughly well studied. There are certain small portions of the lunar surface which have been assiduously studied and drawn by many selenographers, including several well-known living astronomers. It was then pointed out that the region around Hyginus, Triesnecher, and Ukert had been so thoroughly well studied that were a crater of three or four miles in diameter to appear or disappear in this portion of the moon, the fact could be established with certainty. It was also pointed out that these regions formed only one-thousandth part of the visible surface, so that though there might be numerous changes occurring on the lunar surface, it would be unlikely that one should occur in this comparatively small area.

On the evening of May 19, 1877, a German astronomer, Dr. Hermann J. Klein, was examining the portion of the lunar surface around the well-known crater, Hyginus, using a first-class telescope of $5\frac{1}{2}$ inches aperture. The moon had not quite reached its first quarter, so that the sun had only just risen above the horizon of this portion of the moon, and its rays fell very obliquely on the surface, throwing every inequality into broad relief from the long shadows that they cast. For nearly twelve years Dr. Klein had been in the habit of observing this region, so that it was perfectly familiar to him, and he was well acquainted with its appearance. To his great surprise he caught sight of a large black crater filled with shadow, lying to the north of Hyginus, and near the border of the level plain. He felt certain that this crater had not existed on any previous occasion when he had examined this region, for it seemed to be so conspicuous that he was positive he could not have over-

looked it. In this region there are a number of small craters only a mile or so in diameter, and requiring a good telescope and steady air to be seen with ease. The day was not favourable, and only one of these craters could be seen, yet this strange object was most conspicuous and nearly three miles in diameter. Dr. Klein had often seen the small craters, but he had never before seen this great black crater-like object; and it appeared certain to him that he could not have so often seen these small craters and yet have overlooked this great giant right in their very midst. *Was this crater new?*

The great importance of this observation could not be overlooked. It strongly pointed to a new volcanic eruption on the lunar surface. That the object must be new seemed certain to Dr. Klein, for he could not see how it could have been overlooked not only by himself, but by all those who had previously observed, drawn, or mapped this region. It was not seen for a certainty by Schröter, Lohrmann, Gruithuisen, Mädler, or Neison, or they would have mentioned or drawn it in their works on the moon. Was it new? Had it been reserved for him to give to astronomers what they demanded before changing their opinion, a decisive proof of a visible real physical change on the lunar surface?

It must have been with anxiety and impatience that Dr. Klein awaited the next night, when he might again see this strange formation, for during the night all sorts of doubts and difficulties must have sprung up. But the weather was unfavourable, and he could not resume his observations. Day after day went on, and clouds still prevented his continuing his observations, so that he was compelled to wait for the next lunation.

June 18 was the first day that this portion of the moon would be seen under a low illumination, though even then under far less favourable conditions than on May 19. The day arrived and it was fine, and Dr. Klein turned his telescope on this region. Had or had there not been some extraordinary error in his last observation? Would or would he not see a great black crater where no such crater had been seen before? He looked, and in the place where the crater had been visible on the previous occasion, there appeared a great black spot with an ill-defined nebulous border. Was this the great black crater? It was certainly in the right place, and near it he could see the small craters which he had so often seen before. Still on the previous occasion he had seen a distinct crater-like formation, whereas all that was now visible was a blackish spot. It was true that the sun was considerably higher now than before, which would tend to mask the crater-like appearance of the formation. This variation was very perplexing, was this object really a crater or merely a blackish spot? In either case it

seemed to be new, for it had never been seen by any previous observer, whereas it was still far too conspicuous to be overlooked. The moon quickly setting put an end to his observations.

On the next evening Dr. Klein again turned his telescope on this region, but to his surprise the crater-like spot had completely disappeared.

Dr. Klein awaited with impatience an opportunity of obtaining further observations with the view of elucidating this mystery. The Fates were unpropitious. A spell of bad weather set in, and lunation after lunation went by, and no chances were afforded of obtaining additional observations. At last, on November 13, a short observation was obtained of this region on the second day after sunrise, and an ill-defined dark spot was seen in the place of the strange formation, which had looked like a deep crater when seen at sunrise. The next day came, and the spot had again disappeared. It was evident that it was only to be seen for a short time after sunrise, and disappeared when the rays of the sun fell more perpendicularly on the surface. It was again visible on December 13, but only as a dark spot, the sun having then risen some 15° above the horizon of this part of the moon.

These observations threw a good deal of additional light on the nature of this mysterious strange formation. Dr. Klein came to the conclusion that it was a great deep black crater, surrounded by a very low wall and sinking deep into the surface. It appeared to be elliptical in form, and to be over three miles in diameter. At sunrise it seemed to be so conspicuous, that Dr. Klein felt certain that had it then existed it could not have been overlooked by Schröter, Lohrmann, Gruithuisen, Mädler, or Neison, when they had so repeatedly drawn the region. Moreover, he was sure from his own observation that it did not exist prior to 1876. It was then a new formation.

To an experienced observer the features presented by this crater were not new. They instantly recalled to his mind the peculiar crater-like depressions of the far south-west. Far away on the south-west quadrant of the moon, in the wild regions around Fraunhofer, and near Stiborius, there are known to exist a number of deep crater-like formations, with low walls, or even without walls, and penetrating with steep sides deep into the lunar surface. When seen just after sunrise, when the solar rays fall very obliquely on the surface, these formations are seen in the form of deep black craters. As the solar altitude slowly increases and the rays fall less obliquely on the surface, these craters grow more indistinct, and take the appearance of dark grey or blackish spots with ill-defined borders. Gradually, as the solar altitude increases, these spots grow more and more indistinct, and two or three days after sunrise they completely

disappear, and as long as the solar rays fall thus perpendicularly on the surface they remain invisible. These are the very characteristics which marked the new crater which had been seen by Dr. Klein; and his observations seemed to strongly indicate that a crater of this kind had suddenly made its appearance on the level plain north of Hyginus. This rendered the discovery still more extraordinary, for no similar formation was known to exist within nearly a thousand miles of this spot. In fact, it was supposed that they were strictly confined to a region in the far south-west of the moon.

For some time Dr. Klein was unwilling to publicly announce his discovery, being well aware that the great majority of astronomers were of opinion that the period was long passed in which such changes were possible. He wrote, however, Dr. Julius F. Schmidt, the eminent selenographer of Athens, and he learnt from him that though he had frequently observed and drawn this portion of the moon at different times between the years 1860 and 1875, yet he had never seen any trace of such a crater. Shortly afterwards he learned that on again observing this region Dr. Schmidt had at once seen the new object described by Dr. Klein. He determined to publish an account of his observations.

Dr. Klein sent an account of his discovery to the editor of the "Journal of the Selenographical Society," with the view of obtaining the co-operation of the members of the Society in observing this new object. At the same time he published an account of his discovery in two German astronomical periodicals, the "Wochenschrift für Astronomie" for March 27, 1878, and "Sirius" for April 1878.

Dr. Klein's announcement that a great black crater, about three miles in diameter, had suddenly made its appearance on the level plain to the north of Hyginus, where it formed as conspicuous an object as any in this region, instantly aroused the English selenographers. Every extant observation was examined, and every available drawing and map most carefully inspected, but no trace of a crater of this description could be found in the position assigned to it by Dr. Klein. It was thus certain that none of our leading selenographers had ever seen such an object, and this was justly regarded as tantamount to saying it could not have existed prior to 1876, for it was regarded as impossible that such a crater could have existed, and have escaped being seen by astronomers who had frequently observed very much smaller and far less conspicuous objects all around its place. It was further announced that Mr. Neison had repeatedly examined this region between 1870 and 1876, and was certain that there did not exist at that period a great black crater three miles in diameter, and as conspicuous as Hyginus, as the new object was

described by Dr. Klein. Not a trace of such a crater could be detected in any of the photographs, though this was no more than might be expected, for they do not show such objects near the terminator where the crater would be alone visible as such. This combined testimony was regarded by selenographers as establishing for a certainty the fact that no such crater existed in this place prior to 1876. Had then the appearance of a new crater been established, and an instance of a real physical change decisively made out? Not quite. It had yet to be proved for a certainty that such a crater really did exist.

That there was some object in this region which had not been seen before was rendered certain by Dr. Klein's account; but was it an object which could not have been overlooked? If it were really a great deep crater of the character described by Dr. Klein, then it was certain it could not have been overlooked. It must be new. But if it turned out to be a mere shallow depression, or a mere dark spot, it was not likely to have been overlooked, but it might have been, and it would be impossible to regard it as being certainly new. If it were merely a hollow, or a surface marking, or some small inconspicuous depression, then it might have been overlooked. Which of these was really its character? Selenographers awaited with impatience an opportunity of settling this point by making additional observations.

April, May, and June came and went, but the weather was so unfavourable that no observations of any importance could be made in England. Where the crater ought to be could be seen a dark spot such as was described by Dr. Klein. So far his observations were confirmed, but the weather had prevented this region being seen at sunrise when alone the new object was to be seen as a crater. In Germany, however, Dr. Klein was able to see the crater again at sunrise, and he described it as a deep black crater of considerable size and as conspicuous as Hyginus. If therefore these observations of his were confirmed, it must be a new formation.

During the summer and autumn of 1878, the weather continued so bad that no suitable observations of the new crater could be obtained in England. A discussion arose, however, on the question, whether this crater of Dr. Klein's was really new or not. It was pointed out by some astronomers that in the lunar photographs, near the place where it was thought that Klein's crater ought to be, there were shown some white and some dark spots.

Some astronomers thought that one of these white spots must be the supposed new crater, others thought that one of the dark spots was really the crater. After thus identifying the crater on a lunar photograph taken prior to 1876, it was argued that the crater could not be new, and that it showed that no reliance

could be placed on the testimony of those who stated that the crater could not have existed prior to 1876, or they would have seen it. In reply to these objections it was urged, that those objects shown in the photographs were not Dr. Klein's crater, but were well known lunar markings. It was stated by Mr. Neison that he had examined all these photographs, and that in the true position of Dr. Klein's crater the photographs did not show a single object, and that the different dark and light spots shown all round the place of the crater arose from well-known markings on the moon, all of which were shown on his large map made from his observations prior to 1876. This statement was confirmed by Dr. Klein himself, with the important addition that the new crater discovered by him was always completely invisible when the illumination of the moon was such as it was when these photographs were taken.

It may be remarked, however, that this supposed visibility of Dr. Klein's crater on the photographs is of little moment, even were it possible to satisfactorily identify such an object on the photographs. The real point is this, that before 1876 no great deep black crater was visible at sunrise in this part of the lunar surface, though if it had existed it could not have escaped detection, whereas now according to Dr. Klein such a crater does exist, and is visible. The fact of its being visible sometimes after sunrise as a dark spot, though of great interest, is of far less moment, for there are known to be several such dark spots in this region, and two or more might be confounded, and it would be impossible to say that an ordinary small dark spot had not been visible in this region prior to 1876.

On October 3rd the new crater was seen by Herr Bonffay; on November 2nd the new object was seen as a conspicuous crater-like depression by two English observers, Messrs. Rand Capron and Baxendell; and since then it has been seen as a dark spot by several observers. There is, consequently, no doubt that there is some object in this position. Its real nature is not yet established.

It is unfortunate that when the crater has been very obliquely illuminated, and when alone its crateriform character could be ascertained, then it has only been seen by observers who (with the exception of Dr. Klein) are not accustomed to observe the moon, and who are not specially acquainted with this portion of the lunar surface. There are several selenographers who ought to be thoroughly acquainted with this portion of the moon, and who could at once say whether this object of Dr. Klein's was a true crater, which could not have been overlooked by them, or was a small shallow inconspicuous object which might readily have escaped detection. The persistent bad weather, however, seems to have hitherto prevented their seeing this region under suitable

illumination, and consequently the true nature of this remarkable object remains to be determined. Further information, therefore, must be obtained before a decision can be arrived at whether this crater of Dr. Klein's is or is not a new formation.

The great importance of this question is too obvious to need being pointed out, for it would immensely increase the importance of this branch of astronomy, and at once raise selenography into one of the most important fields of astronomical research as it is already one of the most interesting. Let it once be established that great physical changes in the conformation of the moon are still in active operation, and it would lead to the lunar surface being most assiduously studied. And as it has been well remarked by both the eminent selenographer Mädler and the distinguished geologist Phillips, there is little doubt that the careful study of the features presented by the lunar surface would lead to most important discoveries being made as to the career, past, present and future, of not only our satellite the moon, but of its primary, the earth.

ENTOMOLOGY.

By the EDITOR.

"I SHOULD ha' forgot it; I should certainly ha' forgot it," was the exclamation of Mr. Samuel Weller on a well-known occasion; and it was the same phenomenon which acted thus upon the mind of that distinguished character that recalled to the recollection of the present writer an almost forgotten intention to say a few words in praise of the study of Entomology. I can hardly hope to produce anything at all equal to those flowers of eloquence which bloomed in Mr. Weller's valentine under the genial influence of "nine-penn'orth of brandy-and-water, luke;" but the spring of the year seems to be a peculiarly appropriate season for the publication of a plea for entomology, a department of natural history the scientific importance of which seems hardly to be sufficiently recognised, and I must trust to the good nature of the reader to forgive any deficiencies that may be apparent in the present article under the comparison that I have so injudiciously provoked.

It must be confessed that there were few indications of spring in the weather at the time when the shopwindows this year displayed those tempting absurdities which, we may presume, a good many people find pleasure in sending to each other, seeing that their delivery leads to the practical result of a great increase in the postman's labour; but, on the other hand, the matter to which I wish to direct the reader's attention has its interest at all periods of the year, although there is, perhaps, a special fitness at the present season in delivering a lecture on the study of entomology. For while it is quite true that even in winter many exceedingly interesting insects are to be met with, generally by hunting them up in their places of concealment among moss, under the bark of trees, under stones, and in other recondite places, it must be confessed that the entomologist's great harvest is to be reaped during the other three seasons of the year, and it is certainly advantageous for the beginner to commence his researches at a time when the

abundance of insect life surrounding him in all directions, and forcing itself, as it were, upon his notice in all his walks, offers a constant succession of objects of interest. In the spring, when all nature wakes from the torpor of winter, this is especially the case. With the first days of sunshine thousands of insects make their appearance—the solitary bees and sand-wasps are to be seen emerging from the galleries in which they have passed their early stages, or flying busily about the flowers and hovering over the banks of sand or clay in which they are about to burrow and deposit their eggs; the brilliant tiger-beetles flit about sandy lanes and commons, sparkling in the sunlight like living emeralds; the field-paths glitter in the morning with the small carnivorous beetles commonly known as "sunshiners," whose place is taken in the evening by their larger relatives, the great ground beetles (*Carabus*); plenty of that multitude of beetles of various groups which deposit their eggs in the droppings of horses and cattle are seen flying steadily through the air; on the surface of still waters the whirligig-beetle is enjoying his mystic circular dance, while from time to time the water-beetles come quietly up, and, after applying their tails for a moment to the surface, in search of air, plunge down again into the depths; or the water-boatman (*Notonecta*) hangs for a short time in a similar position, with his long oar-like legs outspread ready for action on the least alarm; and even a few early butterflies, the beautiful "Brimstone" especially, flutter gaily through the air. On a fine day in spring or early summer the entomologist perhaps of all men in this *blasé* nineteenth century realises most fully the charm of old Izaak Walton's pastoral. Entomology may not improperly be denominated the modern "Contemplative Man's Recreation."

It is unnecessary, and would lead me too far, to expatiate on the insect phenomena of the summer and autumn—on the succession of new forms which replace or mingle with those of the spring-tide, and keep the interest of the entomologist alive until quite late in the year. But there is one point which I would urge upon the beginner in the study of insects, and that is to yield to that instinct which is sure to prompt him at first to collect and gain some knowledge of *all* the forms which attract his attention, before sitting down to the special investigation of some one department which is almost equally certain to be the result of his further progress. It is only by this means that the full benefit of the study which it is my desire to recommend to the reader can be obtained.

It is, perhaps, hardly necessary at this time of day to vindicate the study of entomology, or indeed of any branch of zoology, from the charge of being merely the amusement of contemptibly frivolous minds. A century ago such a notion

was by no means uncommon; and although some writers of that age occasionally touched upon subjects of natural history, this was done with a tone of conscious superiority, which sounds almost as if the gentlemen in question felt that they were patronising Nature by condescending to take any notice of her productions. The entomologist, especially, was always somewhat of an object of pity, a sort of harmless lunatic. Dr. Johnson, we may fancy, would place him just a step or two higher than that young man who was last heard of "running about town shooting cats"; with others he was a *virtuoso*, and we all know pretty well what that term indicated; and even Richardson, the mild idol of the tea-table, refers to natural-history pursuits in a fashion which may be taken to indicate pretty clearly the estimation in which they were held in his day. Lady G., Sir Charles Grandison's sister, writes of her husband: "He will give away to a *virtuoso* friend his collection of moths and butterflies: I once, he remembered, rallied him upon them. 'And by what study,' thought I, 'wilt thou, honest man, supply their place? If thou hast a talent this way, pursue it; since perhaps thou wilt not shine in any other.' And the best of anything, you know, Harriet, carries with it the appearance of excellence. Nay, he would also part with his collection of shells, if I had no objection. 'To whom, my lord?' He had not resolved. 'Why, then, only as Emily is too little of a child, (!) or you might give them to her.' . . . . . He has taken my hint, and has presented his collection of shells to Emily; and they two are actually busied in admiring them; the one strutting over the beauties, in order to enhance the value of the present; the other curtseying ten times in a minute, to show her gratitude. Poor man! when his *virtuoso* friend has got his butterflies and moths, I am afraid he must set up a turner's shop for employment." There! isn't the badinage delightful? And, as if to point the moral, "a fine set of Japan china with brown edges" is spoken of in the same letter in terms of appreciation, although the fussiness of my Lord G. in connection therewith receives a stroke or two. The gentle, moral Richardson evidently thought entomologists a somewhat contemptible race, as, at a later period, did that redoubtable satirist, "Peter Pindar," whose descriptions of Sir Joseph Banks in pursuit of the "Emperor of Morocco," and boiling fleas to ascertain whether they were lobsters, are pretty well known.

If we consider the origin of this contempt, which undoubtedly until comparatively recent times did pursue the unfortunate entomologist, we may pretty safely refer it to two causes,—in the first place, the ignorance of all natural-history matters which must have prevailed in a society in which Oliver Goldsmith shone as a naturalist; and in the second to the fact, that most of the entomologists of the time were really mere collec-

tors of insects as pretty things, to whom, therefore, the term *virtuoso* was peculiarly applicable. But the mere collecting of insects is surely at least as good as any other manifestation of the *cacoëthes colligendi* which is so general an affection of humanity, and which leads to the accumulation of books in good bindings, of coins and medals, old china, statues, and other works of art, by people who have no true appreciation of their value. Even the making of butterfly-pictures seems to be almost as intellectual an employment as the collecting of postage-stamps, which has been prosecuted with considerable zeal by a good many people in the present day. To this general ridicule we must, I think, add, in the case of entomology, that the practical collecting of insects for amusement was looked upon as a sort of sport, and therefore contemptible, because the game was so small; just on the same principle that the quiet angler is looked down upon by those who love "the noyse of houndys, the blastes of hornys, and the scrye of foulis, that hunters, fawkeners, and foulers make," according to Dame Juliana Berners. Although the marked feeling here alluded to is happily extinct, its effects, no doubt, to some extent survive, and it may be due to them that professed zoologists at the present day unquestionably know less of insects than of any other class of animals.

Nowadays it will hardly be formally denied that all branches of natural history are well worth studying; and it is the object of the present article to show that entomology, however it may have been maligned in the past, presents certain advantages to the intending student which may well give it in many cases a preference over other departments of zoology. It has already been stated that entomological researches may be carried on all the year round, and it may be added that there is no locality in which they cannot be pursued—a matter of no small consequence to that great majority whose connections or avocations tie them down more or less to one spot. Even in the heart of large cities some representatives of most of the orders of insects may be met with; and suburban gardens, if at all favourably placed, may furnish quite a large collection to those who work them systematically. The late Mr. James Francis Stephens used to relate that he had obtained over 2,000 species of insects in the little garden at the back of his house in Foxley Road, Kennington. Short excursions, which the custom of Saturday half-holidays renders particularly easy, will enable the entomologist who is condemned to a town life to have many opportunities of adding to his stores both of specimens and of knowledge, whilst the resident in the country may find fresh objects of interest in whatever direction he turns.

Further, the means of procuring these objects are very simple

and inexpensive. The student of marine zoology may be left out of the question, because a seaside residence is more or less essential for his pursuits; but even he cannot do very much practically without dredging, which is a troublesome and expensive operation. On the other hand, the ornithologist must either buy his specimens, or drag his gun about with him wherever he goes, on the chance of falling in with some desirable species; the representatives of other classes of animals than birds and insects in inland situations in this country are too few to enable them to come into competition with the latter. The entomologist requires only a net or two and a few pillboxes and bottles, all of which he can carry in his pockets, to set him up in his pursuit; and when he brings home his prizes he wants only two or three papers of pins, a few pieces of cork, and a close-fitting box or two lined with cork, for the preparation and preservation of his specimens. No doubt, with his progress, the appliances made use of by the entomologist will increase in number and complexity; but the student of most other branches of zoology must either skin and stuff his specimens or preserve them in spirit or some other fluid, and his collections will in consequence cost more and occupy much more space.

As the characters upon which insects are classified are nearly all external—that is to say, derived from parts which may be investigated without destroying the specimens—their systematic study is very easily pursued, whilst their small size, by enabling a large number of species to be brought together within a very limited space, affords peculiar facilities for the comparison of characters, and for the recognition of the agreements and differences presented by the members of the same group. If the entomologist chooses to go further, and to investigate the anatomical structure of the objects of his study, their smallness may at first sight seem to be an obstacle in his way, but this is soon got over, and it then becomes an advantage, seeing that, owing to it, such researches may be carried on anywhere, without the necessity of devoting a special apartment to the purpose, which can hardly be dispensed with in the case of vertebrate animals. Moreover, as the hard parts of insects are nearly all outside, their anatomy, which is perhaps the most interesting of all, may be studied with the greatest ease, and in fact the most instructive parts of the morphology of insects are those which it is essential for the student to know in order to understand their classification. Thus, for example, the investigation of the structure of the mouth in insects of different orders will give the student a clearer idea of the meaning of the term *homology*, and of the changes which the same parts may undergo in animals, than could be furnished him by any other examples; and the series of modifications, occurring not only in the various types, but even

in the same individuals, at different stages of their development, is most striking and instructive.

Again, these developmental stages, the transformations or metamorphoses of insects, some knowledge of which is also necessary for the comprehension of the classification of these animals, furnish a study of never-ceasing interest, partly for its own sake, partly as giving the student a clear conception of the phenomena of metamorphosis, which plays so important a part in other departments of zoology, and partly from the views which it opens up as to the natural history of insects and their complex relations to the world outside them. Here the parasitism of so many insects in their preparatory stages may especially be cited, as affording an endless and most instructive subject of investigation; and the whole series of phenomena comprised in the life-history of insects affords an easily studied representation of the great system of checks and counterchecks which pervades all nature in the destruction of herbivorous by carnivorous animals, of the latter by other carnivores, and of both by parasites. Indeed, no other class of animals exhibits these interrelations and mutual reactions between different organisms so clearly and so multifariously as the insects. Besides the ordinary division into herbivorous and carnivorous forms, we find many of both series restricted to one particular article of diet, or to nourishment derived from a very few species nearly allied to each other; in their modes of activity insects reproduce those of all other classes of animals, combined with a few peculiar to themselves; the insidious phenomena of parasitism are displayed by them with a perfection of distinctness such as we meet with nowhere else; and their influence is exerted in a thousand ways for the modification of other organisms with which they are brought into contact. Thus, according to Mr. Darwin's theory, which is adopted by a great many naturalists, the action of insects is of the utmost importance in the fertilisation of flowering plants,—nay, as an extension or corollary of this view, we find some who are prepared to maintain that insects are the cause of the development and beautiful coloration of flowers. All these different aspects of the relations of insects to the world outside them open up an infinity of paths for investigation, each of them leading to most interesting and important results, and calling for an exertion of the powers of observation which, as a mere mental training, cannot but produce the most beneficial results. Moreover, so much remains to be done in most of these fields of research, that almost every earnest worker may look forward to the probability of ascertaining some previously unknown facts of more or less importance—a hope which is not without its influence upon most minds. By the knowledge of the facts involved in the recognition of this general system the

entomologist may often render important services to the farmer and the gardener, and thus give a direct practical value to his studies. Nearly every production of the field or the garden is subject to the attacks of insects, which, in case of their inordinate increase, may easily cause very great damage to the crops, or even destroy them altogether. In the face of such enemies the cultivator is often quite helpless, and not unfrequently mistakes his friends for his foes, attributing the mischief produced by concealed enemies to more prominent forms, which are really doing their best for his benefit. In such cases the entomologist may step in to the assistance of his neighbour, indicate to him the real cause of the damage, and in many instances the best remedy, and the best time to employ it.

The asserted influence of insect agency upon the forms and colours of flowers, referred to above, leads to other considerations which may serve to give additional importance to the study of entomology. For while it is believed that plants and flowers are modified by the unconscious influence of insects, it is, on the other hand, at least equally certain that the insects will undergo modifications in their turn; and there seems to be some reason to believe that the great and burning question as to the origin of species, or distinct forms of animals and plants, by evolution—that is to say, the modification of organisms under the influence of external causes, assisted by the survival of those best adapted to the prevailing conditions—will finally be fought out upon entomological grounds. In this respect the careful observation and comparison of the insect-faunas of scattered islands of common origin cannot but lead to most interesting results; as may, indeed, be seen from the brilliant researches of Mr. Wallace upon the butterflies of certain islands in the Eastern Archipelago, and from the elaborate investigations of the late Mr. Vernon Wollaston upon the beetles of the Atlantic islands. In the case of the Cape Verde islands the last-mentioned distinguished entomologist, although a staunch anti-evolutionist, was compelled to admit that he did not believe all the closely related permanent forms which he felt himself compelled to describe as species really owed their existence to distinct acts of creation.

One of the most curious phenomena the full recognition of which we owe to the promulgation of the doctrine of evolution is the *mimicry* or imitation by one organism of the general characters of another, or of some inanimate object, instances of which are tolerably numerous. Here again insects hold the first place. The subject was first approached in a philosophical manner by Mr. Bates, who found in the Valley of the Amazon whole groups of butterflies which imitated most closely the form and coloration of other species belonging to quite a distinct subfamily. Mr. Bates discovered that the imitated forms were

endowed with certain properties which rendered them disagreeable to insectivorous birds, and hence concluded that these mimetic resemblances in general were acquired by a process of selection for protective purposes. Many other instances of the same kind have since been detected in various parts of the world, and they are by no means deficient even in this country.

In the preceding rapid and very imperfect sketch I have endeavoured to indicate the more important of the manifold pleasures and advantages which the study of entomology offers to its votaries, even supposing them to pursue it as a mere amusement. But even in connection with this method of study it has been pointed out that certain philosophical notions will crop up, such as the homology of the parts of the mouth in biting and sucking insects, the phenomena of the metamorphoses and of parasitism, the close inter-relation of diverse organisms, and the question of the origin of species. The influence of such studies in training the mind to habits of observation such as involve the clear appreciation of evidence has also been mentioned as a great and important educational advantage.

There is yet another side to the question. In these days of competitive and other examinations, and of wide-spread science-teaching, great numbers of students learn more or less of what is called zoology from lectures and text-books, their object being in most cases, perhaps, only to pass what they call an "exam." By this means a certain amount of morphological knowledge gets crammed into their heads, but of the practical application of this they are as innocent as the babe unborn. For the due comprehension even of the principles of zoology it is essential that the student should possess something more than a mere book-knowledge, often merely of structural details; and an acquaintance with those principles is becoming day by day more necessary, as natural-history considerations are assuming a more and more prominent position in our general philosophy. How is this to be attained? It is manifestly impossible for anyone who does not devote himself entirely to zoological pursuits to make himself practically acquainted with the whole animal kingdom; he must perforce confine his attention more or less to some special group, and extend the knowledge of the principles and method of zoology thus acquired to the formation of a general conception of the whole. I have already indicated that, from the ease with which it is followed, and the total absence of restriction as to locality, the study of entomology presents special advantages; and in other respects, if pursued in no contracted spirit, its influence on the mind of the student will be at least equally beneficial with that of any other branch of natural history.

THE COLLAPSE OF THE ELECTRIC LIGHT.

By W. H. STONE, F.R.C.P.

Plate V.

IT is hardly matter of surprise that the exaggerated expectations formed a few months ago as to the illuminating power of electricity should have been succeeded by a reaction; and that its practical value, from an estimate that was clearly excessive, should have fallen in public opinion to what is probably an equally unjust depreciation. Nor is it easy to acquit its undiscriminating advocates of ulterior designs, which were to a great extent accomplished in the remarkable, unreasoning, and panic-like depression which occurred in the shares of gas companies. Even if no stockjobbing element intruded itself, there may have been in the excitement a trace of the grim humour so characteristic of Americans, which aims at securing credence for a statement physically impossible by its grave and persistent iteration. It is not many years since the caustic temper of Brother Jonathan was immensely tickled by the universal belief in the older country that the Falls of Niagara had tumbled down; and doubtless he laughed in his sleeve, and chuckled behind a mask of imperturbability, at the pale, anxious faces of gas directors and shareholders. At least one permanent good will have come, at any rate, out of this temporary evil, in the stimulus given to gas-lighting generally, and especially to the urgent need for remedying the discreditable and burglar-encouraging obscurity of our main thoroughfares. "More light, more light," in no metaphorical sense, is now the cry of the English public; and though the tyranny of monopoly, which, in the case of gas, as well as water and drainage, renders the Englishman's house anything but his castle, will probably press heavier than ever, it may at least be hoped that the gas companies, having shown their hands, will for very shame continue to furnish the vastly more perfect system of street-lamps which they have lately inaugurated.

Nothing has conduced to these scientific vicissitudes so much

as the publication of Mr. Edison's specification. This, translated, as is said, from the French, appeared in the "Standard" of Feb. 10, but was rendered comparatively difficult of comprehension by the absence of the figures and diagrams referred to in the text. It was soon followed by a more complete account in the "Engineer" of Feb. 14, from which, by the courtesy of the proprietors, I am enabled to borrow the excellent figures illustrating the present paper (Plate V.). These show the three principal out of no less than forty-eight drawings lodged with the French specification.

Much of his contrivance is of great ingenuity, and evidences considerable mechanical skill. But all competent authorities are agreed in considering that it in no way supersedes existing methods, or that it in any sense fulfils the revolutionising prognostics freely made in its favour. It consists of two parts—1, the means of producing electricity; 2, the lamp.

The electric-magnetic machine is thus described in the specification:—

"It has long been known that if two electro-magnets, or an electro-magnet and a permanent magnet, be drawn apart or caused to pass by each other, electric currents will be set up in the helix of the electro-magnet. It has also been known that vibrating bodies, such as a tuning-fork or a reed, can be kept in vibration by the exercise of but little power. I avail myself of these two known forces and combine them in such a manner as to obtain a powerful electric current by the expenditure of a small mechanical force. In fig. 1 of the drawing a tuning-fork, *a* 2, is represented as firmly attached to a stand, *b* 2. This fork is preferably of two prongs, but only one might be employed, upon the principle of a musical reed. The vibrating bar or fork may be 2 mètres long, more or less, and heavy in proportion. It has its regular rate of vibration, like a tuning-fork, and the mechanism that keeps it in vibration is to move in harmony. A crank and revolving shaft, or other suitable mechanism, may be employed, but I prefer a small air, gas, or water engine, applied to each end of the fork. The cylinder *a* 1 contains a piston and a rod *b* 1, that is connected to the end of the bar, and steam, gas, water, or other fluid under pressure acts within the cylinder, being admitted first to one side of the piston and then the other by a suitable valve; the valve and directing rod *c* 2 are shown for this purpose. The bar of fork *a* 2 may be a permanent magnet or an electro-magnet, or else it is provided with permanent or electro-magnets. I have shown an electro-magnet, *c* 1, upon each prong of the fork—there may be two or more on each—and opposed to these are the cores of the electro-magnets *d*. Hence as the fork is vibrated a current is set up in the helix of each electro-magnet *d* in one direction as the cores approach each other, and

in the opposite direction as they recede. This alternate current is available for electric lights, but if it is desired to convert the current into one of continuity in the same direction a commutator is employed, operated by the vibrations of the fork, to change the circuit connections at each vibration, and thereby make the pulsations continuous on the line of one polarity. A portion of the current thus generated may pass through the helixes of the electro-magnets *c* 1 to intensify the same to the maximum power, and the remainder of the current is employed for any desired electrical operation wherever available. I, however, use the same, especially with my electric lights, but I remark that electricity for such lights may be developed by any suitable apparatus. I have represented commutator springs or levers, *c* 3, *c* 4, operated by rods that slide through the levers *c* 3, *c* 4, and by friction move them. When the prongs *a* 2, *a* 2 are moving from each other the contact of levers *c* 3, *c* 4 will be with the screws 40, 41, and the current will be from line 1 through *c* 1 to *c*, thence to *c* 3 to 41, 43, and to circuit of electro-magnets *d*, *d*, and from *d*, *d* by 42 to 40, *c* 4, and line as indicated by the arrows. When the prongs *a* 2, *a* 2 are vibrating towards each other the circuit will be through *c* 1, *c*, *c* 3, 42, in the reverse direction through the circuit and magnets *d*, *d*, back to 43, and by *c* 4 to line."

Now, the enormous loss of power in a system of magnets in alternating motion will be evident to every student of mechanical laws, as also its inferiority to the simple and regular function of rotation. Moreover, as is well remarked in the "Engineer," the assumption that because a tuning-fork vibrates with small expenditure of power when free, it will do the same when moving in a dense magnetic field, is not only gratuitous but demonstrably false. Many other purely theoretical exceptions may be taken to the machine, such as the bulk of the tuning-fork used, and the impossibility of obtaining from it the necessary rapidity of vibration. It is in the lamp, however, that the principal interest centres, and this is now revealed, as had before been suspected, to depend on the incandescence of platinum or its alloys. The description given of it is as follows:—

"Platinum and other materials that can only be fused at a very high temperature have been employed in electric lights; but there is risk of such light-giving substance melting under the electric energy. This portion of my invention relates to the regulation of the electric current, so as to prevent the same becoming so intense as to injure the incandescent material. The current regulation is primarily effected by the heat itself, and is automatic. In fig. 2 I have shown the light-producing body as a spiral, *a*, connected to the posts *b* *c*, and within the glass cylinder *g*. This cylinder has a cap, *l*, and stands upon a

base, *m*, and for convenience a column, *n*, and stand, *o*, of any suitable character, may be employed. Most of the other figures are in the form of diagrams, to more clearly represent the electrical connections. I remark that it is preferable to have the light within a case or globe, and that various materials may be employed, such as alum-water, between concentric cylinders, to lessen radiation, retain the heat, and lessen the electric energy required; or coloured or opalescent glass, or solutions that reduce the refrangibility of the light, such as sulphate of quinine, may be employed to moderate the light, and the light may either be in the atmosphere or in a vacuum. The materials that I have found especially adapted to use as light-giving substances are set forth hereafter. The electric circuit, fig. 2, passes by line 1 to the post *r*, and by a wire to the lever *f*, thence by the wire or rod *k*, cap *l*, wire *e*, to the post *c*, through the double spiral, *a*, to the post *b*, and by a metallic connection or wire to the post *n*1 and line 4, and so on through the electric circuit, and the light be developed in *a*. The rod *k* will expand in proportion to the heat of the coil, or in proportion to the heat developed by the passage of the current through the fine wire *k*; and, if the heat becomes dangerously high, injury to the apparatus is prevented by the expansion of rod *k* moving the lever *f*, to close the circuit at *i*, and short circuit or shunt a portion of the current from the coil *a*, and reducing its temperature. This operation is automatic, and forms the principal feature of my invention, because it effectually preserves the apparatus from injury. The current need not pass through the wire or rod *k*, as the expansion thereof by the radiated heat from the coil *a* will operate the lever *f*, as indicated in fig. 3, but the movement is not so prompt. It is to be understood that in all cases the action of the short circuit or shunt is momentarily to lessen the current through the light-giving substance, and the circuit-closing devices play up and down at the contact point, maintaining uniformity of brilliancy of light."

The use of incandescent substances for producing the electric light was patented as far back as 1841. The contrivance for preventing fusion or softening is neat and ingenious, but far too delicate for the rough purposes of ordinary illumination. Certain appendices to the principal claim, in the form of secondary batteries, hardly require detailed notice, as not touching the main subject of the patent. The ultimate claims may be reduced to the following:—(1) The combination with an electric light of a thermal circuit-regulator, to lessen the electric action in the light when the maximum intensity has been attained. (2) The combination with the electric light of a circuit-closing lever, operated by heat from the electric current or from the light, and a shunt or short circuit to divert the current, or a

portion thereof, from the light. (3) The combination with the electric light of a circuit-closer operated by heat, and serving to place more or less resistance in the circuit. (4) The combination with an electric light of a diaphragm operated by the expansion of a gas or fluid in proportion to the temperature of the light. (5) The combination with a vibrating body similar to a tuning-fork of mechanism for maintaining the vibration, and magnets, cores and helices, whereby a secondary current is set up, so as to convert mechanical motion into electric force or the reverse. (6) The combination with electric lights of means for regulating the electric current in proportion to the heat evolved, so as to prevent injury to the apparatus.

The question, of course, remains whether this, which is the only complete statement yet made, contains the whole of what Mr. Edison has to divulge. It has been somewhat hastily concluded that this is the patent on which he depends. But both the causes named above may conduce to the keeping back of some important matter by way of a surprise. If, however, this be his complete utterance, there is ground for the disappointment very openly expressed in many quarters.

It is remarkable that nothing is said about the subdivision of the current, one of the points most insisted on in the earlier reports of Mr. Edison's contrivances, nor of the mode of measuring the current.

Another recent contrivance for producing light from electricity falls into the same category as Mr. Edison's, owing to its depending on the principle of incandescence—viz., the Sawyer-Man patent—which deserves brief notice in this place. It is produced from a small pencil of carbon placed in a closed chamber, and separated from the conductors by three diaphragms. The conductors are of copper, shaped so as to have great radiating surface, and thus to prevent conduction downwards into the mechanism of the base. The whole is enclosed in a vessel containing nitrogen, with a provision for fixing any residual oxygen. The wasting of the carbon by oxidation is thus prevented. To obviate the danger of crumbling or disintegration of the carbon from sudden heating, an ingenious 'switch,' or current-diverter, is interposed, the mechanism of which is far too complicated for description without diagrams. The greater part of the light is produced by a small part of the current, and in this condition a very small increase materially enlarges the incandescence. The wires supplying the electricity may be conveniently run through existing gas-pipes, each lamp being supplied with a switch placed in the wall, so that by turning a key the light is turned off or on. As long as the house is connected with the main it makes no difference to the producer whether the lights are on or off, since the resistance of the entire

house-circuit must be overcome. A meter records the time each lamp is on. The cost of lamps and switches will not, it is said, exceed that of gas-fixtures. The meter is a clock with an attachment to throw its hands into connection when the light is on. It does not measure the quantity of electricity passing, but only the time the lamp is on.

It is claimed that one horse-power will give by the Sawyer-Man system a light of thirty 5 ft. gas-burners per hour. Where large power is employed the cost of steam, with every item included, is about one cent per horse-power per hour. The cost of 150 feet of gas at New York prices is 41 cents, or fortyfold dearer. Mr. Sawyer, however, does not rest his calculations on price only, on account of the purity and superiority of the illumination.

It would be difficult to furnish, in conclusion, a fair statement of the varied success which has attended the use of this illumination in London. Perhaps the best instance of steady and pleasant dispersion has been in the burners long ago established in front of the Gaiety Theatre, in the Strand, which have of late been supplemented by an additional lamp in the island for foot-passengers in the middle of the roadway. The effect, which, from the straight and level nature of the thoroughfare, is well seen at a considerable distance on either side, is very powerful and agreeable, resembling strong moonlight. On the other hand, the two lamps placed on the Holborn Viaduct have been a failure from the first, and are now to be discontinued, on account of the cost—seven times greater than that of gas. Some technical mistake has evidently been committed here, as the loud puffing of the portable engine in a neighbouring waste space is to any person acquainted with steam-power entirely incommensurable and excessive when compared with the feeble, coloured and flickering beam of the two opal globes. Probably the fault is insufficient and long conductors, with defective insulation.

An excellent trial in a large confined space is that which has been established for the past month at the Albert Hall. Five large lamps are placed in a ring round the centre of the dome, about fifteen or twenty feet below the velarium. At first they were uncovered, and produced the usual unpleasant effect of solid, heavy shadow; but latterly they have been enclosed in a canoe-shaped case of muslin, which seems to diffuse without materially diminishing the radiation. It must, however, be noted that at the concert in honour of the Duke of Connaught's marriage one out of the five went out about half-way through the concert, which lasted two hours and a half, but was subsequently rekindled; and another failed just after this event, and never reappeared through the evening. The effect on entering

the Hall was startling—somewhat like powerful moonlight. The rendering of colour was very remarkable: both the blue sashes in which Mr. Barnby's sopranos and the red in which his contraltos severally invest themselves appearing with unusual brilliancy; while, on the other hand, the tints of the faces and hands seemed to assume a cadaverous and rather ghastly appearance. The general result was not so agreeable as that produced by the fine ring of star gaslights, set in action by an induction-coil, which usually renders the large Colosseum-like interior one of the best and most evenly lighted in the metropolis.

There seems no reason for altering the opinion already expressed in a former article, that the electric light, while invaluable for exceptional cases, such as for lighthouses, military telegraphy, exploring, or for the masthead lights of large vessels in unknown and hostile waters, and even for stage effects and festive occasions, is neither so pleasant, so safe, so steady, so simple, or so manageable as the better forms of ordinary gas-lighting now universally adopted.

The following extract from the 'Times' of the 22nd instant comes most opportunely to corroborate statements made in the above article. W. H. S.

THE ELECTRIC LIGHT IN THE UNITED STATES.

NEW YORK, March 6.

It is now known that Mr. Edison has failed in his experiments. The most that he has ever yet accomplished has been to maintain 400 coiled iron wires in a state of partial incandescence with a 16-horse power steam-engine. The object of this experiment was to ascertain the number of coils which could be brought to a red heat in any given circuit. It is upon this experiment that Mr. Edison based his claim that he could maintain 20,000 lights burning from one electrical station with a 600-horse power engine. The conclusion was a fallacious one, as Mr. Edison now knows. Platinum must be heated to 2,700 degrees before it attains the intensity of incandescence which is required for illumination, and when the metal is as hot as that it is just on the verge of melting. To prevent the lamp from melting, this inventor has used a regulator consisting of a bar of metal through which the current flowed, which, when the current became too strong, expanded and switched off a part of the current, and thus saved the lamp. In practice this regulator has failed to perform the service required of it. When the current becomes strong, the platinum burner melts in the twinkling of an eye, and the mischief is done before the regulator can act. The inventor believed that he could overcome this practical difficulty, but he has not succeeded. His lamps have continually melted, and he has been unable to keep them from doing so, and the result is that there is great discouragement at Menlo Park. There has been another difficulty. Fourteen out of Edison's sixteen applications for a patent at the Washington Patent Office have been rejected. This impulsive man took up

the electric light last fall as an entirely new subject of experiment, and allowed himself to believe that he saw a way to make the light useful which others had never thought of; but when he reached the Patent Office he discovered that very nearly every idea which he had embodied in his applications had either been covered by the patents of other inventors or was not patentable at all. This information is obtained from the Patent Office, and is one explanation of the discouragement which reigns at Menlo Park. There is no doubt that the Edison light would be a delightful resource for the illumination of dwellings, if it could be depended upon. It floods a room as though with golden sunlight—pure, brilliant, and mellow. But the inventor has never yet been able to regulate his current so as to keep his lamps burning for any length of time, and he has never ventured on a single public exhibition of it. The public have never seen so much as one of his lights yet. A favoured few who have been admitted to his laboratory at Menlo Park have beheld it—a single lamp, enclosed in a glass globe, beautiful as the light of the morning star. But he has refused to let anyone inspect it closely, and has never allowed the exhibition of it privately to last long. He has never been able to depend upon its durability. His apparatus is as far from perfection as it ever was; and, in fact, well-informed electricians in New York do not now believe that Mr. Edison is even on the right line of experiment.

EXPLANATION OF PLATE V.

FIG. 1. Dynamo-electric machine, worked by means of a tuning-fork.

„ 2. Upper portion of the lamp, showing, *a*, the spiral of platinum connected with the terminals, *b* and *c*, and enclosing *k*, the metal rod, which by expansion diverts the current, and prevents fusion of the incandescent wire.

„ 3. Detached figure of the shunting apparatus.

THE FERÆ NATURÆ OF THE LONDON PARKS.

By J. E. HARTING, F.L.S., F.Z.S.

THE extent and variety of animal life which may be found existing in the parks and gardens of London, notwithstanding the co-existence of many unfavourable conditions, is very remarkable, and furnishes a curious illustration of that "struggle for existence" which is being perpetually carried on, not by man alone, but by all living things.

In the midst of so densely populated a city as ours, where the vegetation of the open spaces is being constantly trodden under foot, or struggles upward with difficulty through an atmosphere of smoke and sulphur, it would hardly be supposed that any wild creature—unless the rook and the ubiquitous sparrow may be so termed and excepted—could find either sufficient food or sufficient freedom from molestation to enable their existence. The inquisitive naturalist, however, well knows that the case is otherwise.

It is, of course, many years since any of the larger *ferœ naturœ* were to be found in the London parks, although many persons still living must remember the deer in Hyde Park; and may have had pointed out to them the places where the last otter was speared, and the last hare killed.

Before considering the attractions which the parks at present afford to the naturalist, it may be not uninteresting to glance briefly at their former condition. When, in exchange for the priory of Hurley, in Berkshire, Henry the Eighth, in 1536, acquired from the monks of Westminster the manor of Hyde, the park, of larger dimensions than we now see it, was fenced in for the greater protection of the deer which were preserved there, and frequently hunted. In that year a royal proclamation was issued, in which it was stated that "as the King's most Royal Majesty is desirous to have the games of hare, partridge, pheasant, and heron preserved in and about the manor of his palace at Westminster, for his own disport and pastime, no person, on the pain of imprisonment of their bodies, and further punishment at his Majesty's will and pleasure, is to presume to hunt or hawk from the palace of Westminster to St. Giles' in

the Fields, and from thence to Islington, to our Lady of the Oak, to Highgate, to Hornsey Park, and to Hampstead Heath."

In several succeeding reigns Hyde Park served as a royal hunting-ground. Edward the Sixth, while yet a boy, hunted there in 1550 with the French Ambassadors. In 1578, when John Casimir, Duke of Bavaria, paid a visit to Queen Elizabeth, he stayed at Somerset House, and amused himself with hunting at Hampton Court, and shooting in Hyde Park, where it is recorded that in February of that year "he killed a barren doe with his pece from amongst ccc other deere." *

The Queen herself used evidently to witness the sport, if she did not actually take part in it, as she did elsewhere,† for in the accounts of the Board of Works for the year 1582 is an entry of a payment "for making of two new standings in Marybone and Hyde Park for the Queen's Majesty and the noblemen of France to see the hunting." It is to these, probably, that Norden, the topographer, alludes when describing the place about this time. He writes: "Hyde Park, substantially impayled, with a fayre lodge, and princelye standes therein. It is a stately parke, and full of fayre game."‡

James the First continued to preserve the game here with great strictness; and in October 1619 some deer-stealers were executed at Hyde Park Gate, and with them a poor labourer, whom they had hired for 1*s.* 4*d.* to hold their dogs.§

In January 1625, a warrant was sent to the keeper of Hyde Park to cause three brace of bucks to be taken to Marybone Park, to supply the scarcity caused by the great rain there; and another warrant to the master of the toils, for the toils to be sent to Hyde Park for the purpose.‖

St. James's Park, which, prior to the time of Henry the Eighth, was little better than a marshy field, was in his reign enclosed and stocked with deer.

There were no less than eleven ponds there in James the First's time. These were turned to account by being stocked with fish and waterfowl, and the park was then much improved and ornamented with walks and fountains. The part of the park now called the Enclosure was staked off from the walks by Charles the Second for the purpose of protecting the deer and other animals of which he was very fond.

The collection of waterfowl maintained by Charles the Second in St. James's Park must be familiar to all who have read the

* Lodge's "Illustrations of British History," 1791, vol. ii. p. 205.

† Letter from Rowland White to Sir Robert Sidney, dated September 12, 1600; and Nichols' "Progresses, &c., of Queen Elizabeth," vol. iii. p. 90.

‡ Norden, "Survey of Middlesex and Hertfordshire," 1596, p. 19.

§ Calendar of State Papers, Domestic Series, 1619–23, p. 88.

‖ Ibid., 1623–25, p. 445.

diverting pages of Evelyn and Pepys. The park at this time, says Evelyn, was "stored with numerous flocks of several sorts of ordinary and extraordinary wild-fowl, breeding about the decoy, which, for being so near a city, and among such a concourse of soldiers and people, is a singular and diverting thing." *

In William the Third's time a proclamation was issued for the preservation of game "within ten miles of the Court of Whitehall and the precincts thereof." This proclamation, which was published in the "London Gazette," in October 1690, forbade the keeping of "a fowling-piece, gun, setting dog, net, trammel, or other unlawful engine," by any person "other than such as shall be by law qualified;" and such as gave information concerning offenders to John Webbe, living in St. James's Park, were to be rewarded.

Grosley, in his "Tour to London," 1772, especially notices the deer in St. James's Park, and remarks that "in that part nearest Westminster nature appears in all its rustic simplicity —a meadow regularly intersected and watered by canals, and with willows and poplars without any regard to order."

Deer were to be seen in Kensington Gardens for some time after the commencement of the present century, and remained in Hyde Park until the year of the Queen's coronation when, a great fair being held there for some days, they were removed to Bushey, and never replaced.

The last wolf is thought to have been killed in England during the reign of Henry the Seventh, at which period this animal had become so extremely scarce as to be confined to a few of the wilder and more remote districts in the North of England.†

Its extinction in the neighbourhood of London dates some centuries earlier, and we are happily unable to include it in our present list. But there is a story on record of a wolf at large in St. James's Park, which may be appropriately quoted here.

In 1739, near the Vineyard, in St. James's Park, lived a gentleman who kept a wolf. One night in January in that year the animal broke loose and found its way into the park. The first human being he saw, early in the morning, was a milkman, at whom he flew furiously. The man set down his pails and took to his heels; and as the milk was apparently more tempting to the wolf than the milkman, he began at once to drink it, during which time the man escaped. The animal having thus refreshed himself, and espying a calf at a little distance, immediately killed and partly devoured it; but fortunately while thus engaged he was found by his keeper and recaptured before he could do any further mischief.‡

* Evelyn's Diary, February 9, 1664–5.
† See "Pop. Sci. Review," 1878, p. 150.
‡ Larwood, "London Parks," vol. ii. pp. 175–6.

The fox as a lurker in the London parks survived to a comparatively recent date. So late as the end of the last century a good many were still to be found in Hyde Park, and the Ranger used to carry a gun in his walks for the purpose of shooting them whenever he had a chance. There is extant a minute of the Board of Green Cloth, dated in 1798, granting a pension of 18*l.* to Sarah Gray, in compensation for the loss of her husband, who had been accidentally shot by one of the keepers whilst they were hunting for foxes in Kensington Gardens.* These animals were but the natural attendants upon the hares and pheasants which existed in the parks at that date. When game was no longer preserved there, and henroosts were not at hand, the foxes must have left their quarters there, or starved. The Ranger's gun probably hastened their extinction by a few years only.

So long as the parks were on the outskirts of London so long was there a chance of accession to the number of *ferœ naturœ* within their precincts from the country beyond; but so soon as houses crept up to and surrounded the parks, and the latter became more and more resorted to by the public, the impossibility of preserving the game became apparent, and the attempt was abandoned.

A curious hare hunt took place in Hyde Park in October 1809, and resulted in the death of what was, perhaps, the last hare killed in that park. At that time, and for many years afterwards, there were only a few detached houses north of the Uxbridge Road, an alehouse or two by the roadside, and, farther on, two little hamlets in the midst of the fields—viz., Craven Hill and Westbourne Green—for Paddington was then limited to a row of houses along the Edgware Road. A hare having found her way into Hyde Park from the adjoining country, was suddenly discovered on the open space between the Barracks and the Serpentine; and as soon as she was started all ranks joined in the chase. Poor Puss, finding retreat impossible, took to the Serpentine and swam rapidly across. But the alarm having spread to the other side, before she could land numbers were waiting ready to receive her. At length, being afraid to attempt a landing, and almost exhausted by terror and fatigue, she seemed to be drowning, when a boy jumped into the water and seized her. A gentleman immediately released her from her pain by killing her, and, giving the boy a crown, carried away the prize.

For some years after this, the Regent's Park—then private royal property—held plenty of hares, and between 1824–28 coursing matches used to be held there.

The marshy pools in Hyde Park which once occupied the site

* Smith, "Historical Recollections of Hyde Park," 1836, p. 39.

of the Serpentine, and afforded sanctuary to the herons which Henry the Eighth was at such pains to protect, were at one time the haunt of otters. These animals would find their way up the two small streams which entered London from the west and north-west, viz., the West Bourne and the Eye Bourne (Tyburn); and, remaining concealed by day, would find their food at night amongst the coarse fish which tenanted the pools. But when, in 1730, all the ponds were united into the handsome piece of water called the Serpentine, the streams covered in, and the ground cleared and made more ornamental, the home of the otter was destroyed. For some years afterwards, however, a stray one seems now and then to have reappeared, but only to meet with that reception from a crowd which, prompted by thoughtlessness and inhumanity, is usually accorded to strange animals.

During the summer of 1739 a large dog otter took up its abode in St. James's Park, and there made free with his Majesty's fish. For a long time it escaped all the gins and snares laid for it; but at length its death being resolved on, a regular otter-hunt was organised, at the desire of the Earl of Essex, who was then Ranger, and Sir Robert Walpole's pack of otter-hounds was borrowed for the occasion. The otter had taken shelter on Duck Island, but was soon driven into the moat, and was closely pressed by the hounds at his frequent "venting," though sometimes he dived half the length of the canal which surrounded Duck Island. After a long chase he left the water, and attempted to run to the great canal, but before he reached it he was speared by Mr. Smith, the huntsman of the pack. This unprecedented otter-hunt took place in the presence of his Royal Highness the Duke of Cumberland, the Earl of Essex, and several other noblemen, who, armed with spears, all took an active part in the sport. According to the papers of the day, the animal measured five feet in length.

But although so many years have elapsed since this incident occurred, it is by no means the latest date at which the otter has been met with in the neighbourhood of London, if not actually in a London park. In March 1829 a young otter, about eight months old, was killed at Kilburn in a field which is now the site of the railway station. In the autumn of 1831 an otter haunted the Brent, where the head of Kingsbury Reservoir now is. The reservoir was not then formed, and at that particular spot was a famous bed of flags, well calculated to afford shelter to such an animal. About the end of September or beginning of October in that year this animal was shot. A third otter was seen for several months during the latter part of 1847 about the brook between Hendon and Edgware, and was several times hunted by the harriers of Mr. Dancer, of Kenton, but never killed. A fourth, which was described as a very fine

large animal, was observed early one morning, by a policeman on duty, crossing the park belonging to Lord Mansfield, at Hampstead, and making for the water. It was subsequently seen by several other persons, some of whom, known to the writer, laid in wait to try and shoot it, but without success. This was in the spring of 1855.

But perhaps the most extraordinary capture of an otter in London was that which was made in 1863. On March 25, in that year, as a coachman was proceeding at daybreak along Aberdeen Place, leading from Maida Hill to St. John's Wood, he observed an otter trotting along close to the wall, and overtaking it, succeeded by repeated kicks with his heavy boots in killing it. It was then taken to Mr. Gardner, of Holborn, for preservation, where the writer saw it on the following day. It was a young animal, of very moderate dimensions; and if it had not escaped from confinement, its appearance in such a place can only be accounted for by supposing that it had come up the Canal to Maida Hill; and being unwilling to keep to the water through the tunnel, was following its course above ground, and if unmolested would probably have entered the Canal again in the Regent's Park.

It is doubtful whether the squirrel was ever an inhabitant of the London parks, no record of its appearance there being extant, although, from its having been met with in the woods of Hampstead, Highgate, and Hornsey, it is not unlikely that it was at one time common enough on the north side of London. In all probability the park trees, although affording shelter enough to screen these little animals from observation, would not supply sufficient food suited to their requirements.

During the long summer evenings, bats may not unfrequently be observed on the wing, not only in the parks, but even in the London streets. At least four species have been identified, conspicuous amongst which is the great noctule—the *Vespertilio altivolans* of Gilbert White—which has frequently been observed in Kensington Gardens. We have on several occasions seen the pipistrelle on the wing in Oxford Street—sometimes quite early in the afternoon; and we once examined a specimen of Natterer's bat which was caught in Thayer Street, Manchester Square. The fourth species referred to is the long-eared bat, which, next to the pipistrelle, is perhaps the commonest species of all.

From the present aspect and condition of the parks it is evident, as might be expected, that the majority of the existing *ferœ naturœ* belong to the feathered rather than to the four-footed tribes; and the number of birds, both resident and migratory, which may be detected there by a good observer is not a little remarkable.

Although the days have long since gone by when kites used

to carry off the offal from the streets of London, and build their nests in Hyde Park and in the clumps of trees in Gray's Inn, one of these birds was observed no longer ago than 1859 passing over Piccadilly.* Almost the only birds of prey still to be seen occasionally about London are sparrow-hawks and kestrels. The former are sometimes taken in the act of dashing at cage-birds when hung up near a window, three or four such instances having come to the writer's knowledge. In April 1871 a pair of kestrels had a nest in the cable attached to the anchor of the naval hero on the summit of the column in Trafalgar Square.

We have more than once observed a peregrine falcon passing over London, where, there is reason to believe, these birds occasionally make a temporary stay, frequenting the church-tops and roofs of public buildings, attracted no doubt by the pigeons, which furnish them with many a meal. A pair for many years frequented the top of St. Paul's, where it was supposed they had a nest. When the royal hawks were kept at the Mews, at Charing Cross, the "eyess" falcons were probably "flown at hack" in Hyde Park, but on this point no contemporary writer gives any information.†

Aubrey gives an anecdote related to him by Sir Edward Sherborne, of a sparrow-hawk belonging to Charles the Second. "Not long before the death of that king," he says, "a sparrow-hawk escaped from the perch, and pitched on one of the iron crowns of the White Tower, and entangling its leash in the crown, hung by the heels and died. Not long after, another hawk pitched on one of the crowns." This anecdote is given under the head of "Omens." ‡

Perhaps the most ancient birds now in London are the rooks, numerous colonies of which exist, not only in the parks, but in other open spaces, and even in the gardens of private houses. The history of these rookeries has lately been furnished in a very entertaining article by Dr. Edward Hamilton,§ since which some additional details have been published by Professor Newton.‖

The history of the rookery in the Temple Gardens is rather curious. It is said to have been founded in Queen Anne's time

* See "The Zoologist," 1859, p. 6676.

† The royal hawks were kept at Charing Cross during many reigns (according to Stow, from the time of Richard II., in 1377), but they were removed by Henry VIII., who converted the Mews into stables. The name, however, confirmed by the usage of so long a period, remained to the building, although after the hawks were withdrawn it became inapplicable. But what is more curious, in more modern times, when the people of London began to build ranges of stabling at the back of their streets and houses, they christened those places "mews," after the old stabling at Charing Cross.

‡ Aubrey's "Miscellanies," 1696. (Ed. 1784, p. 59.)

§ See "The Zoologist," 1878, pp. 193–199.

‖ "The Zoologist," 1878, pp. 441–444; and Yarrell's "History of British Birds" (4th ed.), vol. ii. p. 290.

by Sir William Northey, who colonized the place with birds from his estate at Epsom. A bough was cut from a tree with a nest containing two young rooks and taken in an open waggon from Epsom to the Temple, and fixed to a tree in the gardens. The old birds followed their young and fed them, and they remained and bred there. The following year a magpie built her nest in the gardens: her eggs were taken and those of a rook substituted, and in due course were hatched there.*

That magpies formerly nested in St. James's Park we learn from a story which has been preserved to us from Charles the First's time in connection with one of these birds. Amongst the numerous Frenchmen who flocked to this country in 1638 in the wake of Queen Henrietta Maria was a certain M. Souscarrière, who although a notorious cheat and gambler, had contrived to insinuate himself into good society and came to London to recruit the health of his purse. He brought tennis-players, lute-players, and singers with him, as he said, to amuse the natives, and ere long gained large sums of money by gambling. On one occasion, however, he was cleverly overreached. For a long time he secretly practised to throw a tennis-ball into the nest of a magpie in one of the trees in St. James's Park; and when he saw that he could manage it, he took a heavy bet with some unsuspecting gentleman that he would lodge a ball in the nest in a certain number of throws. Unfortunately for Souscarrière he had been observed practising this trick by another gentleman, who, the day before the bet came off, filled the nest with moss, so that the ball could not roll into it, and the Frenchman lost his wager, to the great amusement of all who were in the secret.†

The carrion crow is occasionally observed in the London parks; and we have more than once seen the hooded or grey crow, in winter, in the Regent's Park—generally engaged in robbing the ducks of their food. On the 8th and 9th of November, 1874, a hooded crow was seen feeding on the lawn of the Inner Temple Gardens. It flew from tree to tree, occasionally dropping on to the grass, and was apparently not at all scared by the crowds of people assembled on the Thames Embankment to see the Lord Mayor on his return from Westminster.

The jackdaw makes himself at home in Kensington Gardens and Holland Park, living in holes in some of the old trees, and making excursions in all directions. His presence may often be detected when flying homeward with the rooks by his smaller size and sharper cry.

* This account was communicated to the writer by a son of the late Mr. Everest, who, in conjunction with Mr. Pownall, published, anonymously, in 1825, a History of Epsom.

† Larwood, "London Parks," vol. ii. p. 77.

Amongst the old trees in Kensington Gardens both the greater and lesser spotted woodpeckers may be occasionally seen; the latter being the commoner bird of the two, although the former has been known to breed there. Both species have been noticed also in the Regent's Park.

To give any detailed account of the numerous small birds which have been observed to frequent the London parks and gardens at different seasons would carry us far beyond the limits of the present article.* It must suffice if we refer briefly to some only of the more noteworthy.

Amongst these the nightingale should, perhaps, stand first. Several naturalists have detected its presence in summer in the Regent's Park; and of late years a favourite resort of this bird has been the Flower Walk, in Kensington Gardens, whence its unmistakable notes have been poured forth in April and May to numbers of delighted listeners. Skylarks sometimes visit Hyde Park, where we have occasionally both seen and heard them.

Few would expect to find in the great metropolis so sylvan a species as the cuckoo, and yet this bird not only passes through town on its way to and from its summer quarters, but occasionally stays long enough to commit an egg to the care of some dupe of a foster-parent. In August 1870 we observed a cuckoo in Lincoln's Inn Fields; and in August 1876, while passing from Bedford Row to Gray's Inn Square, we saw a cuckoo fly across Gray's Inn Gardens and pass over Holborn in a southerly direction. It was flying so low that it only just cleared the tops of the houses. An observant friend, who pays frequent visits in the early morning to the Botanical Gardens, Regent's Park, discovered that the reed warbler breeds there every summer; and in the nest of one of these birds, in 1872, he found the egg of a cuckoo. The following summer he was much interested in observing a young cuckoo sitting in the centre of a growth of large heracleums and being fed with caterpillars by a reed warbler. At the lake in the same gardens the kingfisher is sometimes seen, generally in autumn, and occasionally makes a protracted stay. In August 1863 a kingfisher was seen frequently at the Ornamental Water in the Regent's Park.

Amongst the few observations of Gilbert White which relate to birds in London is one which has reference to the house-martin. He says: 'I have not only seen them nesting in the

* In the "Proceedings of the Zoological Society" for 1863 (p. 159) will be found a list, by Mr. Bartlett, of no less than fifty-seven species of birds observed by him in the Regent's Park; and Mr. F. D. Power, in the "Zoologist" for 1865 (p. 9727), has furnished another list of twenty-four species which he noted as having occurred in a single square in London—Queen's Square, Bloomsbury. A resident of Gray's Inn in the course of ten years found that twenty different kinds of birds had been seen there by him. See "The Field," March 11, 1876.

Borough, but even in the Strand and Fleet Street; but then it was obvious, from the dinginess of their aspect, that their feathers partook of the filth of that sooty atmosphere.' * Further on he says: 'In London a party of swifts frequents the Tower, playing and feeding over the river, just below the bridge; others haunt some of the churches of the Borough next the fields, but do not venture, like the house-martin, into the close, crowded part of the town.' †

A pair of ring-doves nested for many years in an old tree in the Green Park, where they were last observed in 1877.

Early in July 1873 an immense flock of swifts was observed passing over Hyde Park to the westward, at a height of about a hundred yards from the ground. It was estimated that there must have been 1,500 or 2,000 of them—a most unusual congregation for this species.

Did space permit we might give particulars of the appearance of many uncommon birds (that is, uncommon for London) which have alighted at various times in different parts of the metropolis, and amongst which we should have to name the partridge, quail, snipe, woodcock, and stork.

Snipe and woodcock have frequently been picked up, and almost invariably in the vicinity of telegraph-wires, against which they must have flown when passing over the city at night. General Oglethorpe, who died in 1785, and who was considered the best shot of his day at birds on the wing, frequently killed woodcocks, in company with his friend Carew Mildmay, on the ground where Conduit Street now stands.

During severe weather strange wildfowl, such as pochards, scaups, and coots, occasionally alight upon the lakes in the London parks; and now and then a diver makes its appearance. We have observed the little grebe upon the Round Pond, in Kensington Gardens; and were not a little surprised one summer to find this bird nesting there, the nest, a floating, shallow structure, being moored to some aquatic plants at a distance from the shore.

At the periods of migration in spring and autumn gulls and terns occasionally visit the Serpentine, and never fail to attract attention, from the contrast which their snow-white plumage presents with the surrounding landscape.

To see all these and many other birds which we have not named the observer should be astir early, ere the noise and traffic of a busy day drives them to concealment, or, it may be, to leave the neighbourhood. In these morning walks in town it is curious how the eye and ear may be gladdened with rural sights and sounds which few would expect to meet with in the heart of a great city.

* Letter XVI., to Daines Barrington.
† Letter XXI., to same.

REVIEWS.

THE STUDY OF ROCKS.*

THIS book well supplies a want long felt by students of Petrology in this country. Several valuable text-books on the subject have within the last few years been published on the Continent, but Mr. Rutley's volume is the first purporting to afford elementary instruction on the study of rocks by the aid of the microscope, which has appeared in the English language.

The work is divided into two parts—Rudiments of Petrology, and Descriptive Petrology.

Beginning with a chapter on methods of petrological research, the author proceeds to consider the origin of rock-masses and of the various disturbances to which the earth's crust has been subjected, as well as the general characters and modes of occurrence both of eruptive and sedimentary rocks.

A minute description is given of the appliances and methods employed for the preparation of sections suitable for microscopical examination, as well as of the microscope and accessories best suited for this class of investigation. A chapter follows on the examination of the optical characters of thin sections of minerals; and the first division of the work terminates with a lucid description of the principal rock-forming minerals, including both their megascopic and microscopic characters.

The second division, which is devoted to a description and classification of the various eruptive and sedimentary rocks, affords evidence of much careful consideration, and furnishes a fair epitome of the present state of our knowledge of this subject.

The text is illustrated by a large number of woodcuts, which, although not elaborate, are always clear and effective. A few slight oversights of a kind incident to all first editions have been observed, but the book is generally characterised by clearness and accuracy. It will therefore be welcomed by all who may wish to acquire a competent knowledge of Petrology, but more particularly by those unacquainted with German and French, in which languages all previously available works on this subject have been written.

From its somewhat limited extent, certain subjects have of necessity received but small attention, although nothing of importance appears to have been omitted. We therefore heartily recommend Mr. Rutley's volume

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* "The Study of Rocks, an Elementary Text-book of Petrology." By Frank Rutley, Esq., F.G.S., H.M. Geological Survey. London: Longmans, 1879.

to the student of Petrology, who, as the author himself remarks, must bear in mind that he cannot become acquainted with this subject by reading alone, and that the work before him does not pretend to be more than a systematic rudimentary guide.

WATTS'S DICTIONARY OF CHEMISTRY.—Third Supplement.*

THE present Supplement brings the general Record of Chemical Discovery down to the end of the year 1877, and includes some of the more important discoveries of 1878. As, however, it comprises an unusually long interval of time, it has been found necessary, in consequence of its large size, to publish it in Two Parts.

The author acknowledges his obligations to Professor E. J. Mills, F.R.S., for an article on Cumulative Resolution; to Professor J. E. Thorpe, F.R.S., for one on Flame; and to Mr. R. Warrington, F.C.S., for articles on Forest-trees and on Barley.

Among the more important articles on Inorganic Chemistry are those on Alum, Anorthite, Antimony, Arsenic, Barium, Bismuth, Boron, Borates, Cadmium, Cæsium and Rubidium, Cerite Metals, Chlorine, Chromium, Chrysocolla, Clays, Cobalt, Copper and its Alloys, Corundum, Didymium, Enstatite, and Felspars.

The portion relating to Organic Chemistry comprehends articles on Acetamide, Acetic Acid, Ammonia derivatives of Acetone, Acrolein, Amyl, Alcohols, Anthracine, Alizarin, Benzamide, Benzine, Benzoic Acid, Butyl Alcohols and Ethers, Chrysoïdine, Cinchona, Cinchonine Group, Citric Acid, Cumene, Cyanamide Cyanates, Cymene, Diamenes, Diconic Acid, Dye Stuffs, Ethers, and Fermentation.

The article on Arsenic comprehends a list of the sulphur-salts of that metal which are produced when hydrosulphides are saturated with arsenic pentasulphide. Under the heading of Copper, the Hunt and Douglas process for the wet extraction of that metal from its ores is described, as well as the employment of phosphorus in the process of copper-refining.

The methods used by Hautfeuille for the production of artificial crystals of orthoclases and albite are given under the head of Felspar, as well as a large number of recent analyses of the different members of this important mineral group. The views of Tschermak and Vom Rath on the one hand, and those of Descloizeaux and Petersen on the other, relative to the constitution of the triclinic felspars, are concisely and clearly stated; and this article may be regarded as affording a lucid summary of the present state of our knowledge on this subject.

The articles on Organic Chemistry have been prepared with the care and exhaustiveness for which Mr. Watts is so distinguished; while Mr. Warrington's article, of twenty-five pages, on Forest-trees is a valuable monograph on that important and interesting subject.

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* "A Dictionary of Chemistry and the Allied Branches of other Sciences." By Henry Watts, B.A., F.R.S., &c. Third Supplement, Part I. London: Longmans, 1879.

ANIMAL MORPHOLOGY.*

SOME three years ago Prof. Macalister, of Dublin, published what was intended to be the first part of an introduction to the Morphology of Animals, in which he treated of the Invertebrata. The second part, relating to the Vertebrates, is now published, but as an independent work, forming part of the "Dublin University Press Series." It is, we think, to be regretted that this sort of separation should have been made between what ought to have been the two volumes of one book, but we presume that financial considerations have had some influence in leading to the adoption of such a course, and if so, we must not quarrel with the author on this account.

Professor Macalister's present volume, like the former one, is literally an introduction to the morphology and broader classification of the animals of which it treats; the habits of the animals, their geographical distribution, and other matters relating to their natural history, are almost wholly unnoticed, and thus the book, whilst admirably fitted for a student's text-book, will prove disappointing to anyone who mistakes it for a general treatise on zoology.

It is, however, as a student's text-book that the author intends his book to serve, and its *raison d'être* is explained in the following passage from his preface, in which he justifies the use of the word "Introduction" in its title, at which, it seems, some reviewers have cavilled. "I remember when a student," he says, "that I found the gap between most manuals then existing and the monographic literature of zoology to be so great, that, passing from the first to the second was practically entering an unknown region; and hence in this work I have tried to make each part sufficiently comprehensive to enable the student, who wishes for additional knowledge of any forms, to pass from a general study of morphology into the region of detail, without any great intermediate gap."

This quotation sufficiently explains the object Prof. Macalister had in view in writing this book, and in most respects he has well fulfilled it. Starting with a short statement of the general characters common to all vertebrate animals, he next indicates the characteristics of the two primary groups, Acrania and Craniota, the former now represented only by that singular creature the *Amphioxus*; and then proceeds to describe the structural modifications exhibited by the classes, orders, and subordinate groups recognised by the most recent writers on the different sections of vertebrates. The classification is carried as far as the families, of which, however, very brief characters are given.

Throughout, so far as we can judge, Prof. Macalister has given an excellent summary of the structural characters of all the great groups of vertebrate animals, including in all cases the history of the development of the embryos, which occupies so important a place in all recent morphological work. The special groups founded for the reception of fossil forms are also described in connection with those including their existing allies.

As a matter of course it would be easy to raise objections to some parts of

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* An Introduction to the Systematic Zoology and Morphology of Vertebrate Animals. By Alexander Macalister, M.D., &c. 8vo. Dublin: Hughes, Foster, and Figgis. London: Longmans. 1878.

the classification adopted by our author, which, as already indicated, is founded upon the views put forward by the latest writers upon the different groups. But in a case to which the old proverb "so many men, so many minds" is peculiarly applicable, to insist upon such objections would be absurd. For our own part, we cannot help regarding the establishment of eighteen orders of birds as unnecessary, and as masking absolute relationships; but the author has the authority of Prof. Huxley and others on his side, and must not be blamed for adopting what is really the result of the analytical method of studying zoology now prevalent, and due to the fact that the leading students of that science have been for years becoming more and more pure anatomists and less zoologists in the broad sense of the term. To the same circumstance it is owing that Prof. Macalister's work bristles with technical terms in every line, a characteristic which was animadverted upon rather severely, in connexion with his former volume. The fact is, however, that the Professor is hardly the guilty party in this instance. He found the terms in use, proposed by men whose names bear authority, and he is perhaps rather to be praised than blamed for having used and explained them for the benefit of his readers. The fault lies with the inventors of such a multitude of terms, who seem to forget, in the desire to introduce the greatest possible precision into their descriptions of the structure of a given group, that there are hundreds of other groups equally deserving of being treated in a similar fashion, and which, being actually so treated, give rise to a terminology of the most fearful extent and difficulty. If matters go on long in the present fashion we shall have to learn a new technical language for every group of animals. The thing has already gone to a very considerable length, and as Prof. Macalister has clearly defined most of these modern morphological terms of art, his use of them in the present book will be of advantage to those who really wish to master the study of animal morphology.

In this, as in his former volume, the author has adopted the plan of printing details in small type. It is illustrated with a few woodcut figures and diagrams, which aid greatly in elucidating some of the more obscure points to which the author has to refer; and a tolerably copious Index, generally containing references to the definitions of technical terms, adds considerably to the value of the volume, which may be recommended as a very useful guide for the practical student.

THE ZOOLOGY OF VICTORIA.*

BESIDES publishing the results of the geological and botanical investigations of the colony which have now been in progress for a good many years, the Government of Victoria seem resolved to do what they can for the elucidation of its zoology, and accordingly Prof. McCoy has just brought out the first part of a work on this subject which promises to be of great interest and value. From his preface it appears that, with the view of

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* "Natural History of Victoria. Prodromus of the Zoology of Victoria; or, Figures and Descriptions of Living Species of all Classes of the Victorian Indigenous Animals." Decade I. By Frederick McCoy. 8vo. Melbourne. London: Trübner & Co., and G. Robertson. 1878.

securing accurate representations of those animals which readily undergo important changes after death, even when preserved in spirit, many drawings and descriptions have been made from fresh or living specimens as opportunities occurred; and from these and other materials it is proposed to publish from time to time "decades" of plates, with descriptive letterpress, but in no particular order, to be supplemented by a final systematic volume for each class so soon as the investigation of its members inhabiting the region can be approximately completed.

The first of these decades is now before us, and we must congratulate Prof. McCoy upon the commencement of what will evidently be a work of great importance, not only in the colony, but to naturalists in all parts of the world. Poisonous snakes are so rife in Australia, and the means of distinguishing them a matter of so much interest to the colonists, that we do not wonder to find the first three plates in this decade occupied by species of Elapidæ, which appear to rival their dreaded relative, the Indian cobra, in the virulence of their venom. Three more plates are devoted to marine fishes, namely, a sea bream (*Chrysophrys australis*) and two fine species of gurnards. One of the latter (*Lepidotrigla vanessa*), here correctly figured for the first time, is very beautifully coloured. The seventh plate represents a "giant earthworm" (*Megascolides australis*), which is said to reach a length of six feet when extended to the utmost. It agrees in its general character and habits with the species with which we are sufficiently familiar in this country. On the eighth plate we find representations of three species of moths of the genus *Agarista*, in all stages of growth. These figures are of special importance in the colony, as one of these moths, although a native of Australia, has taken to feed on the introduced grape-vines with such avidity as to cause very considerable damage. Plates 9 and 10 show two butterflies of the genus *Pieris*, with their transformations. Full descriptions of all the species are given, accompanied by a few remarks on the natural history of the animals.

Of the plates we must speak in high terms of praise. The figures of the animals are well drawn, and printed in colours in a style which may well excite our wonder that such work can be turned out in a place which was a howling wilderness not fifty years ago. Each plate bears, besides the principal figure or figures, representations in outline or otherwise of those details which are of most importance for the determination of the species, and altogether Prof. McCoy and his assistants have evidently done their best to make the work a most valuable one. That they have been remarkably successful so far we need hardly say, but it is a question whether any of us will live to witness the completion of the work, if the entire Fauna of Victoria is to be illustrated in a similar fashion.

PRACTICAL GEOLOGY.*

UNDER the title of "Practical Geology," Mr. Harrison has added another work to the list of smaller manuals of geological science, one of the

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* "Practical Geology." By W. J. Harrison, F.G.S. Sm. 8vo. London: W. Stewart & Co. 1878.

objects of which is to show the reader how to see for himself the leading facts of geology. With this view the author in the first three chapters gives the preparation for the study, the kind of apparatus required, the mode of investigation in the field, and the method of determination of rocks, assisted by their microscopical examination. After noticing the nature of the oldest rocks, the formations, from the Cambrian to the Recent period, are successively described. Each chapter is complete in itself, and contains a clear and readable description of the occurrence, lithological structure, divisions, and principal life-forms of the strata noticed, together with brief allusions to their economic bearings and effects upon scenery. Throughout, the subject-matter is concisely treated, and this little manual will form a serviceable guide to the geological classes for whom it was more especially intended. Some slight corrections may be found necessary; and the illustrations would have been more instructive if they had been more carefully executed.

THE "CHALLENGER'S" VOYAGE.*

AT the first glance we were inclined to say of this book, "Here is another unsatisfactory outcome of the voyage of the 'Challenger,'" the first chapter or two seemed so tame and *jejune*. On reading further, however, it appeared that this was due, in part at any rate, to the fact that the wind had been taken out of Mr. Moseley's sails by Sir Wyville Thomson's prior publication, relating to the voyage in the Atlantic, and perhaps in part to the fact that the author had not got thoroughly warmed up to his work, for he tells us in his preface that the greater part of his narrative was written n board the ship, and "sent home from the various parts touched at, in the form of a journal." Later on, indeed immediately after the departure from the West Indies, the author apparently takes a fresh start, and the remainder of his book is so good that, although we cannot quite endorse the opinion of some critics who place it on a level with the admirable "Journal of Researches" of Charles Darwin, it may certainly be characterised as one of the best records of scientific travel that we possess.

Leaving the details of the dredgings and deep-sea soundings which constituted the principal business of the "Challenger's" voyage to other hands for description, Mr. Moseley records the general incidents of the voyage, and his impressions of the localities visited, but intersperses these with many exceedingly interesting and valuable observations on various subjects of natural history. Among these scientific notes marine objects, of course, occupy a considerable space, but the author's remarks relate to a greater extent to the productions of the land, and as the ship in the course of her four years' wanderings touched at a great number of out-of-the-way places, Mr. Moseley has been enabled to make many valuable additions to our stock of natural history information.

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* "Notes by a Naturalist on the 'Challenger': being an Account of Various Observations made during the Voyage of H.M.S. 'Challenger' round the World, in the years 1872–76." By H. N. Moseley, M.A., F.R.S. 8vo. London: Macmillan. 1879.

As to the most important of these, it may, however, be a question whether they relate to the zoology of the sea or the land, the subjects of them being the sea-birds and seals. Upon the habits, and especially the nesting, of the noddies, frigate-birds, penguins, gulls, albatrosses, and other sea-birds which occur in such abundance on the almost inaccessible rocky islands scattered over both oceans, Mr. Moseley has much to say, and his descriptions of the "rookeries" inhabited by these birds are particularly interesting and valuable. But where all is so good, it seems rather invidious to select parts for special notice, and it will be almost sufficient to say in general terms that wherever the "Challenger" went, Mr. Moseley appears to have kept both his eyes and his mind open and active, and that he has been singularly successful in transferring his thoughts and observations to paper.

Upon a vast number of the subjects here treated of, although they may have been dealt with by previous writers, our author's remarks and reasonings possess an originality which gives them a special value of their own; whilst in some cases, as in the account of the curious genus *Peripatus*, and in the description of the hydrozoan corals, the Milleporidæ and Stylasteridæ, he gives us the results of his own original researches. The geological structure of the localities visited comes in for a due share of attention, and in connection with this department of science we find some valuable observations on the glaciation of such out-of-the-way spots as Heard Island and Kerguelen's Land. An entire chapter, and a most interesting one, is devoted to the author's observations among the antarctic ice, the phenomena presented by which in its various floating forms are described in considerable detail and illustrated by a good many figures.

The above are the principal natural history matters on which Mr. Moseley discourses at any length; but throughout his narrative we find scattered an infinity of useful observations upon the various interesting facts in zoology and botany which struck him during his long journey, both by land and sea, and his concluding chapter is devoted to a special review of the phenomena of animal and vegetable life at the surface of the ocean and in the deep sea as revealed by the investigations of the scientific staff of the "Challenger." This final chapter contains a great many philosophical reflections on the facts observed, and may be regarded as giving an excellent summary of the present state of our knowledge of pelagic and abyssal animals. At the same time it shows that in some respects there are still elements of uncertainty in the recorded observations. Thus according to the generally accepted views there is a surface fauna and a deep sea fauna, but we hear of nothing between them, although Mr. Moseley seems to think that the vast intervening space is not wholly uninhabited, and suggests a method of investigation which would probably give novel and interesting results. On the other hand, we have the curious connected facts of the occurrence of brightly coloured organisms, blind organisms, and others furnished with greatly developed organs of vision. Why should these peculiarities occur? If the assumed darkness of the bottom be the cause of the blindness of some species, why should others be so well provided with eyes? for we cannot believe that the latter organs would be developed, as Mr. Moseley suggests, for the purpose of making use of the light emitted by phosphorescent animals, of which,

moreover, we do not know that they are phosphorescent in their natural habitat at the bottom of the deep sea. Is it absolutely proved that these abysses are really in perpetual darkness, and that no microscopic plants live in them?

Besides recording his scientific observations, Mr. Moseley's narrative gives a pleasant and readable account of the terrestrial localities visited, their scenery, architectural and social peculiarities, and inhabitants. With regard to the last, indeed, our author has a good deal to say especially in relation to Japan (with which country and its occupants he seems peculiarly charmed), and several of the islands of the Pacific. When we consider that the course taken by the "Challenger," after leaving the southern ice, carried her by New Zealand, Tongatabu, the Fijis, the New Hebrides, the Moluccas, the Philippines, New Guinea, the Admiralty Islands, Japan, the Sandwich Islands, and Tahiti, and that at all these localities Mr. Moseley had, and made good use of, the opportunity of examining into the characters, habits, and manners of the natives, the reader will easily understand that scattered through his agreeable pages there is an immense amount of information which will be welcome to the student of anthropology. In fact, in every respect, this book is one of the most important contributions to our scientific literature that has appeared for a long time. The only thing that the reader will regret is that it is not rather more freely illustrated; the woodcuts, although generally good, are not numerous; and there are only three plates, two illustrating antarctic icebergs and pack ice, and the third a chart showing the track of the ship and the contours of the sea-bottom.

ANATOMY OF THE ELEPHANT.*

UNDER the title of "Studies in Comparative Anatomy," Professor Miall, of Leeds, has commenced the publication of a series of small volumes each of which is to contain the results of some personal investigation in comparative anatomy. The first of these treated of the structure of the skull of the crocodile, one of the most instructive subjects that the author could well have selected; in the second, which is now before us, he describes the anatomy of the Indian elephant, from a dissection of a young female specimen made by him with the co-operation of Mr. F. Greenwood. As this investigation relates especially to the muscles and other soft parts, it can hardly prove so generally attractive as the former treatise; but as it contains a great many new facts and corrections or completions of the statements of former authors, it will be of great value to that increasing body of comparative anatomists who do not consider that their study ought to be confined to the bones. The dissection of so large a beast as an elephant is a work of no small labour; it appears to have occupied the authors about three years, and they recommend to future dissectors of large animals the adoption of the mode of preservation employed by them, which is sufficiently described (p. 8).

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* "Studies in Comparative Anatomy." No. II. "Anatomy of the Indian Elephant." By L. C. Miall and F. Greenwood. 8vo. London: Macmillan. 1878.

THE CHEMISTRY OF COMMON LIFE.*

PROFESSOR Johnston's "Chemistry of Common Life" has long been advantageously known for its simple and familiar method of introducing chemical facts and reasonings to the general reader. Treating, as this work does, of the air we breathe; we water we drink; the soil we cultivate; the plants we rear; the bread we eat; the beef we cook; the beverages we infuse: the sweets we extract; the liquors we ferment; the narcotics we indulge in; the odours we enjoy; the smells we dislike, &c., and concluding with a recapitulatory chapter upon the circulation of matter, it possesses great interest for all who are desirous of learning something of the chemical and physical relations existing between themselves and the world which they inhabit.

When, twenty-five years ago, "The Chemistry of Common Life" was first published, an acquaintance with the advancing science of the day was possessed by a very limited number only, even among the educated classes; and Professor Johnston's popular exposition of the fundamental principles regulating our daily life laid open to the public a new world of interest and speculation. In preparing the present edition for the press Professor Church has followed the arrangement and method adopted in the original work, and has made such additions and corrections only as the progress of science may have rendered necessary. He has, however, in the aggregate contributed much original matter, as well as an entirely new chapter on the colours we admire; besides which many of the new analyses, and particularly those of roots, are either wholly or entirely the results of his personal investigations.

The new chapter contains a notice of the red colouring matter of blood, now known as *hæmaglobin*, which contains iron, and differs from all other constituents of the body in various important particulars; among the most remarkable of which is its property of absorbing gases. On this latter peculiarity depends one of the chief uses of the blood as a carrier of oxygen throughout the system.

Another animal pigment, having a still more remarkable composition than that of hæmaglobin, and to which the name of *turacin* has been given, was, some years since, discovered by the editor in the pinion-feathers of ten or eleven different kinds of birds peculiar to Africa, and known as Touracous or Plantain-eaters. About fifteen feathers in each wing present patches which are almost entirely red, and a chemical examination of such feathers shows that they owe this colour to a pigment containing about eight per cent. of copper, so bound up with the other elements present as to be incapable of removal by any treatment short of the destruction of the colouring matter. The existence of an animal pigment so rich in copper is an exceedingly curious and interesting fact, but one of which the whole history is still far from being thoroughly understood.

The black feathers of some birds, black human hair, and, possibly, the skin of certain mammals likewise contain a dark pigment capable of resisting the action of tolerably strong sulphuric acid. Sorby obtained one

* "The Chemistry of Common Life," by the late James H. W. Johnston, F.R.S.S. L. & E., &c., a new edition brought down to the present time. By Arthur Herbert Church, M A., Oxon. 8vo. Edinburgh and London: Blackwood & Sons. 1879.

grain of this substance from 100 grains of the feathers of the common rook, and found it to contain carbon 55·4, hydrogen 4·25, nitrogen 8·5, and oxygen 31·85 per cent. This chapter also furnishes much valuable information relative to the colouring matter of plants, such as leaf-green or *chlorophyll*, &c., as well as with regard to the more important of the coal-tar products employed for dyeing purposes.

Although the present edition appears in the form of a single volume, it contains a much larger amount of letter-press than former issues; and by judicious additions and careful revisions Professor Church has succeeded, not only in bringing the information down to date, but also in doing so without in any way changing the general system of the original work.

UNITED STATES SURVEYS.

IN our last number we published an abstract of the Report of a Committee of the National Academy of Sciences on the Consolidation of the Surveys of the United States. We do not know what action, if any, has been taken upon this document, but most certainly the important Geological and Geographical Survey of the Territories over which Dr. Hayden so admirably presides shows no present signs of any diminution of its activity. Three stout octavo volumes which have reached us since our last issue seem to be anything rather than signs of decrepitude.

The tenth annual report* describes the completion of the survey of Colorado and the adjacent territories, and includes treatises on the geology, topography, archæology, and ethnology of that wonderful region, together with some notes by Prof. Lesquereux on cretaceous and tertiary fossil plants obtained by the survey in Colorado in 1877, and a catalogue by the same author of plants from the above formations in North America generally, and further, a report of Dr. Packard on insects affecting the cranberry and the pine. The catalogue of North American cretaceous and tertiary plants will be found especially useful.

The geological portion of the work consists of a series of reports from the geologists in charge of the different districts, completing the Commentary on the splendid atlas of Colorado noticed in our October number. As usual in each report the structural geology and superficial formation of the district are very fully described, and the latter offers a series of the most extraordinary phenomena that are to be seen anywhere on the face of the earth. All these parts are illustrated with a great number of plates of maps, sections, and views.

Of special reports under the geological head we may mention Dr. Endlich's description of the eruptive rocks of Colorado, a most important contribution to our petrographical knowledge; and the same author's mineralogical report, which includes an alphabetical catalogue and systematic arrangement of the

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* "Tenth Annual Report of the United States Geological and Geographical Survey of the Territories, embracing Colorado and parts of adjacent Territories, being a Report of Progress of the Exploration for the year 1876." By F. V. Hayden, U.S. Geologist. 8vo. Washington: Government Printing Office, 1878.

minerals ascertained to exist in Colorado. The mining capabilities of the districts surveyed are mentioned in the geological reports.

The topographical section contains the report of Mr. A. D. Wilson, the chief topographer, on the primary triangulation of Colorado, giving many interesting particulars as to the methods adopted; special topographical reports on the White River and Yampa River divisions of the country; and Mr. Henry Gannett's report on the arable and pasture lands of Colorado, which includes a general description of the physical geography and climate of the region, besides the account of the capabilities of different parts of the country for agricultural and pastoral pursuits.

As illustrations of these two sections three of the large maps of the Colorado Atlas have been printed on thin paper, so as to be capable of folding into octavo size, and appended to the volume—namely, the general geological map of Colorado, the economic map, and the drainage map; and the addition of these adds greatly to the value of the book. In fact, so conscious are the people of Colorado of the importance of the labours of Dr. Hayden and his assistants that on January 14 last the General Assembly of that new state passed a vote of thanks to them for their co-operation in the completion of this great work, on the ground that "the publication of the reports, views, and maps of this survey form a collection invaluable alike for the advancement of science and the development of the mining and agricultural interests of the state." Those who are acquainted with the publications here referred to will agree that this expression of gratitude is well deserved.

The third section of the volume, which is devoted to the archæology and ethnology of the region, will be studied with much interest. It includes descriptions by Mr. W. M. Holmes and Mr. W. H. Jackson of a great number of those extraordinary ruins, towers, and cave-dwellings which have been lately discovered in such abundance in the far West, with details of pottery, picture-writings, stone implements, and other objects, manufactured by the former inhabitants of these valleys. These traces and relics of a race that has passed away are exceedingly interesting; and the reader is assisted in forming a clear idea of them by a most liberal allowance of illustrations, including maps, ground-plans, views, and figures of manufactured articles. Many pieces of the pottery are of very elegant form or beautifully ornamented; others are ruder, or exceedingly grotesque, such as the vessels in the form of birds which figure upon three or four of Mr. Jackson's plates.

In Chaco Cañon, North-western New Mexico, a human skull was discovered "at a depth of 14 feet beneath the surface, lying upon a stratum of broken pottery." The soil overlying the skull is described as alluvial drift. Dr. W. J. Hoffman describes and figures this cranium, which he regards as having belonged to a "cliff-dweller"; it presents a very great flattening of the hinder part of the skull. Dr. Hoffman also communicates some ethnographic observations on Indians inhabiting Nevada, California, and Arigona, giving some interesting particulars as to the manners and customs of the various tribes.

Still referring to Colorado, we have to notice the commencement of Dr. Elliott Coues' "Birds of the Colorado Valley,"* forming the eleventh volume

* "Miscellaneous Publications, No. 11. Birds of the Colorado Valley, a repository of scientific and popular information concerning North American

of the miscellaneous publications of Dr. Hayden's Survey.—This first part, which contains the descriptions of the Passerine birds from the thrushes to the shrikes (including warblers, tits, creepers and wrens, larks, wagtails, tanagers, swallows, waxwings and greenlets) occupies 565 pages, so that it will easily be understood that the subject is treated in some detail; in fact, the feelings suggested to the British zoologist by the contemplation of such a book have a slight tinge of envy in them, seeing that he can never hope to get an opportunity of displaying to such advantage the results of his labours. Dr. Coues gives a detailed synonymy of each species, followed by a Latin diagnosis and a description in English, and then indicates the general natural history of the bird, and indulges in any critical remarks that may occur to him. The latter are often of considerable importance both with regard to genera and species. He also adds in many cases notices of other American species nearly allied to those inhabiting the district to which his work specially relates, and sometimes even tabulates all the species of a genus, a plan the adoption of which is very useful in works on local natural history. The illustrations (seventy in number) consist of woodcuts generally of heads and other important parts, and although not remarkable as works of art, are generally sufficiently characteristic.

Curiously enough, we find Dr. Coues reviving the old question as to the hibernation of swallows which we had thought had been set at rest long ago. He does not indeed affirm his positive belief in their passing the winter, as alleged, buried in mud at the bottom of ponds and rivers, but he declares that the occurrence of this phenomenon rests on as good evidence as many other things which are accepted as facts in natural history, and that his mind, at any rate, is open to conviction. He says, "I see no reason why a swallow should not stay awhile in the mud in a state of suspended animation, or greatly lowered degree of vital activity. The thing is physically and physiologically feasible; it is in strict analogy with observed phenomena in the cases of many other animals; and it is not more marvellous than catalepsy, trance, and several other conditions of life, the rationale of which is still obscure." The point from which the *à priori* argument against the hibernation of swallows in mud starts is, however, precisely the conviction that such a phenomenon is *not* "physiologically feasible"; and even Dr. Coues himself adverts specially to the difficulty of explaining "the suddenness of the alleged transition from a high state of animation to a degree of lethargy, and the abruptness with which the activity of the vital functions is said to be arrested." His supposed analogy drawn from the swifts is really, when we come to consider it, no analogy at all; and we do not actually know of any bird that has been proved to hibernate, hibernation being in reality (*à priori* at any rate) incompatible with the physiological constitution of birds. It must be confessed, however, that in reviving this question, Dr. Coues has done all in his power to furnish the means for its solution, in the shape of an elaborate bibliography of the subject extending over nearly a dozen pages. Ornithological bibliography must, indeed, occupy a considerable portion of Dr. Coues' attention, for besides the piece above alluded to, we find close by

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Ornithology." By Elliott Coues. Part I. 8vo. Washington: Government Printing Office, 1878.

a special bibliography of the waxwings (genus *Ampelis*, Linn.), and these are stated to be only portions of a great Bibliography of Ornithology not yet completed, but of which one section, namely that showing "the North American section of the 'Faunal Publications' series, including titles and digests of works and papers relating solely to birds of North America indiscriminately, collectively, or in general," is published in advance as an appendix to the present volume. When we say that this portion relating solely to works and memoirs on the general avifauna of North America, or containing notices of birds not confined to any particular group, occupies nearly 180 pages, some idea may be formed of the labour which the compilation of the whole must have entailed upon the author. The titles of the works here are arranged in order of date, but to facilitate reference the list is provided with two alphabetical indexes, one containing the names of authors, and the other the localities referred to. This bibliography will prove of the greatest value to all ornithologists.

Few are the insects that have been honoured by having a special treatise all to themselves. The goat-moth caterpillar—"*La chenille qui ronge le bois de saule*"—was anatomically immortalised by Lyonet; the hive-bee and the silkworm have had many panegyrists; the cochineal, a much smaller species, has also had its independent book; and Southall devoted his "Treatise of Buggs" to a subject which most people will regard as rather unsavoury. The Colorado potato-beetle, also popularly described as a bug, had his little treatises all to himself; but with this, so far as our recollection serves, the list of species of insects which have arrived at the dignity of having their history narrated in separate publications, is pretty nearly exhausted.

The Rocky Mountain locust (*Caloptenus spretus*) has now to be added to this honourable list, in consequence of the publication of a volume of nearly 800 pages devoted exclusively to the history of his life and misdeeds, and to the best mode of punishing him for the latter, and preventing his ravages in the future.*

This elaborate report, which is also brought out under the auspices of the Geological and Geographical Survey of the Territories, is the joint production of MM. C. V. Riley, A. S. Packard, Jun., and Cyrus Thomas, and it is not too much to say that it reflects the highest credit upon them. Of the importance of the subject to the United States some conception may be formed from the fact that the Commissioners estimate the loss from the ravages of this locust to the states between the Mississippi and the Rocky Mountains, during the five years 1873–77, at 200,000,000 dollars, and they point out that the injury thus inflicted was the more severely felt as the losses fell most heavily upon a frontier population without wealth.

The permanent habitation of this formidable locust, which is, however, individually but a small insect, about the size of an ordinary English grasshopper, is a great stretch of country lying principally east of the Rocky Mountains, extending northwards into British territory, and including within the United States the territories of Nebraska and Wyoming, and portions of Colorado, Dakotah, and Nebraska. Here the species is always to be found

* "First Annual Report of the United States Entomological Commission for the year 1877, relating to the Rocky Mountain Locust." 8vo. Washington: Government Printing Office, 1878.

in more or less abundance, and hence it makes its injurious raids upon the more highly cultivated districts lying around it. In a considerable stretch of country lying east of these permanent abodes of the locust, the insect is described as subpermanent, that is to say, its invasions are there very frequent; and further, it is in the habit of breeding there for several consecutive years, after which it again disappears for a time. Over a much larger extent of country, reaching southwards to the coast in Texas, and stretching westwards through Colorado over a considerable space west of the Mountains, the locust is said to be temporary, visiting those regions only periodically, and generally disappearing within the year. The migrations of these insects take place in two directions; that is to say, while the invaders make their way in all directions from the permanent breeding grounds, the young locusts hatched out in the temporary regions migrate in the opposite direction, or back towards the permanent abode of the species; and the Commissioners state that it is well established that there may be, at the same time, two contrary currents over considerable areas. At the same time, it is remarked that many of the returning insects are so infested with parasites, and otherwise diseased, that they perish during their homeward journey.

The habits and natural history of the species are fully described by the authors, who also indicate the characters by which it may be distinguished, from nearly allied but distinct species also inhabiting the North American continent. They further describe minutely the anatomy and embryology of the locust, and explain its transformations, and, in fact, furnish the reader with all the information necessary to enable him to form an intelligent conception of the nature of this scourge of the Western farmer. A more encouraging chapter is that which treats of the insect-enemies of the locust, which fortunately appear to be pretty numerous and active in their operations—to the entomologist this will be one of the most interesting portions of the work. A great many birds also aid materially in checking the increase of the pest. Three chapters are devoted to the consideration of the available modes of destroying the locusts by artificial means, some of which are ingenious enough, but need not be referred to here. A chapter on the effects produced on the fauna and flora of different localities in consequence of devastation by locusts is very interesting and instructive. The authors notice the occurrence of locusts in other localities, especially in countries bordering upon mountain ranges; but as a set-off against the mischief done by the insects, they indicate that they are available "as food for various animals, including man, as fish-bait, or as manure," and further that "the chemical analysis given of the dead locusts is quite interesting. The insects furnish a new oil, which we have christened Caloptine, and a very large percentage of formic acid." Of their properties as food Mr. Riley speaks from experience in very favourable terms. A great body of evidence bearing on the subject of the report is given in a series of appendices. The volume is illustrated with several maps and numerous wood engravings, and with five very nicely executed plates, three of them showing the distinctive characters of the three North American *Calopteni* referred to in the text, the fourth representing the hypermetamorphoses of the coleopterous genera *Epicauta* and *Hornia*, distinguished enemies of the locust, and the fifth illustrating certain points in the histology of the latter.

A MYCOLOGICAL REVIEW.*

IT is a question that must of necessity force itself upon the mind of nearly every naturalist, whether we are not getting overdone with periodical literature. Every little Philosophical Society that exists all over Europe publishes its contribution to the literature of science, and although most of the articles contained in these almost inaccessible serials are commonplace enough, still, from time to time, they contain the results of sound original observations with which it is of importance that all students of the subject treated of should be acquainted. In other cases we have local Natural History journals brought out, either by individuals who find a pleasure in editorial work (!), or by a combination of local societies, and these are in precisely the same position as the former. We cannot help thinking that this indefinite multiplication of serial publications, in any one of which a valuable paper may be buried without the least chance of being generally known to those interested in it, is a great misfortune, as it involves a totally unnecessary widening of the literary field which the naturalist must explore, and which is wide enough in all conscience without these additions.

A similar objection may perhaps be raised against the production of journals, transactions, and other serial works intended specially for the reception of papers upon some particular class or order of plants or animals; but, although these have, to a certain extent, the same effect of multiplying the receptacles which the student must search through in order to acquaint himself with what has been done, they, nevertheless, in their very title tell him what he may, or rather, what he need not, expect to find; and for those who devote themselves more particularly to one department of Natural History, it must be confessed that they present a great advantage. Further, by notices of new publications, and abstracts of papers published in other more general journals, they furnish the specialist with a reflection of what is going on elsewhere in his favourite pursuit, and enable him, if he chooses, to procure all the best literature relating to it.

For these reasons, we welcome the appearance of the first number of a quarterly "Revue Mycologique," edited at Toulouse by M. C. Roumeguère, and can only hope that its existence may not be typified by that of the plants whose history and peculiarities it is intended to record. At the same time we cannot help feeling that the editor's undertaking is at least as "courageous" as those of the gentlemen who have started the "Revue Bryologique" and "Revue d'Algologie," to which he refers in his opening address to his readers.

This first number contains several articles by the editor—one in opposition to the notion that Lichens are Fungi parasitic upon Algæ, another on an extraordinary development of *Bovista gigantea* near Toulouse, a third on the origin of the genus *Microsphæria*, a fourth on the preservation of Fungi, and a fifth on *Telephora palmata*, forma *paradoxa*. We also find a decade of new Exotic Fungi described by M. F. von Thümen; an article on the

* "Revue Mycologique, Recueil trimestriel illustré, consacré à l'étude des Champignons." Dirigée par M. C. Roumeguère. 1re Année, No. 1. 8vo. Toulouse, 37 Rue Riguet, et Paris, J. B. Baillière. January 1879.

Myxogastres by Dr. L. Quelet; and one by the Count de Castillon on the Artificial Culture of Mushrooms by the Japanese. A paper by M. Paul Brunaud on the popular names of Fungi in the neighbourhood of Saintes contains notes on the characters of two or three species. A plate which accompanies the number does not appear to belong to any of the papers contained in it. The number furnishes bibliographical notices of a great number of books and papers published in 1878, and concludes with a few pages of short notes on mycological subjects. If this review can be continued in the same style, it will doubtless prove exceedingly useful to students of Fungi; but we should fear that its circulation will be very limited, and, probably in anticipation of this, its price seems to be rather high.

HEALTH PRIMERS.*

THE six little volumes which have appeared of this very useful series are remarkable for their sound common sense treatment of important subjects, and for their cheapness. In this last respect these primers resemble many others which have appeared from time to time, and which have been the work of the most distinguished physicists, anatomists, and botanists of the day; but they differ from them by being within the comprehension of those individuals for whom primers are written. A primer in the olden time was a book which related to the fundamental principles of a branch of knowledge, and it was written in plain and almost monosyllabic English; but many modern ones are comprehensive "crams," and *prime* up the student with the incomprehensible. The one was "milk for babes," the others are "strong drink" for the old; the old books were for the beginner, and the modern are only really appreciated by those men who know all about the subject. Certainly these little books can be understood by everybody; they are didactic as well as suggestive; and in reading them one is struck with the evident improvement in the method of thought of the medical profession, for they are edited and written by distinguished members of the faculty. They are the outcome of the third phase of medical thought during this century. Early in it, the doctors were heroic; people were bled, blistered, and draughted, and were taught that every disease had, or ought to have, its special curative agent. Then, as the medical mind became logical, the expectant treatment prevailed; and now primers are written on "preventive" medicine or sanitary science. Formerly every epidemic was attributed to the anger and personal attack of the Ruler of all things, and was considered to be a warning against national and other sins. Now such disorders are believed and are proved to be the result of man's stupidity, dirt, bestiality, and bad government. The little volume on "premature death"—that is to say, death before the expiration of the natural term—deals with the community rather than with the individual, and tells the true story of the cause and

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* "Premature Death: its Promotion and Prevention." "Alcohol: its Use and Abuse." "Personal Appearance in Health and Disease." "The House and its Surroundings." "Exercise and Training." "Baths and Bathing." Royal 16mo. London: Hardwicke & Bogue.

perpetuation of those preventible diseases which are a scandal to the country. It explains the influence of artificial conditions and methods of life on the young and old, and very ably notes the influence and reactions of destitution on disease. It is pleasant to read the grateful recognition of the services of "the great master in sanitary science and craft in this country, John Simon," a man to whom England owes a mighty debt of gratitude, a man who has saved and not slain his thousands, and who in our present, militant, money-grubbing, semi-barbarism is plain "John Simon." The primer on "Alcohol: its Use and Abuse," will not please either the total abstainer or the wine-selling grocer tribe. It is written by a thinker, and the following sentences prove it:—"Moral character is very largely influenced by habit, by the acquired control of the highest cerebral centres over the lower; and hence the continual paralysis of that control, and the constant abolition of all power of self-restraint, must, of course, aid largely in moral deterioration." "The habitual drunkard is morally defective from the outset, and his habits give full play to the action of all the lower tendencies of his nature. Drunkenness is more a vice than a disease." The author then affirms, with regard to moderate or excessive drinking, "that whatever quantity causes any temporary loss of moral control does, if repeated, lead to moral deterioration, but that short of this no such result is produced." At the close of this book there is a very solemn warning against the use of stimulants in painful diseases; it is for the especial benefit of those who run a chance of being made slaves to the bottle by illogical *medici*. The house we live in—too often a den of malignant bacteria, bad gases, and smells—is treated of in one of the primers in a very downright manner. If builders have consciences, and would only read this book, what a blessing it would be! The remaining volumes are on the special subjects of exercise and baths, and, like the others, are full of suggestions and of very good advice. We can earnestly recommend these able volumes to the public.

THE LIBRARY OF THE MUSEUM OF PRACTICAL GEOLOGY.*

WE may call the attention of those of our readers who are interested in geology to the very useful Catalogue of the contents of the library of the Museum of Practical Geology, which has just been published. It has been prepared with great care by Mr. Henry White, the compiler of the Royal Society's catalogue of scientific memoirs, and Mr. T. W. Newton, the assistant-librarian at Jermyn Street, and is not only an excellent example of a practical library-catalogue, but, from the nature of its contents, giving as it does a list of accumulations of geological and mineralogical works especially during a period of some twenty-seven years, it will prove exceedingly useful, even apart from the library to which it particularly relates, as an index to the literature of geology and the allied sciences. Very wisely the compilers have abstained from all fancy methods of arrangement, and have

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* "A Catalogue of the Library of the Museum of Practical Geology and Geological Survey." Compiled by Henry White and Thomas W. Newton. 8vo. London: Printed for Her Majesty's Stationery Office. 1878.

kept absolutely to an alphabetical order, certainly the most convenient for reference; at the same time certain articles have been collected under special heads, but always, where necessary, with cross-references. By the use of black letter for the names of authors, &c., the book is rendered particularly easy to consult.

GEOLOGICAL SURVEY OF ESSEX AND HERTS.*

WE have received from the authors a copy of the memoir on Sheet 47 of the Geological Map of England and Wales, published under the superintendence of Mr. Whitaker, in which that gentleman and his colleagues carry farther to the northward the geological survey of the London basin, so well treated by him in a former memoir. The present work relates to the north-west of Essex and north-east of Hertfordshire, and takes in small portions of Cambridgeshire and Suffolk. It thus carries the survey of the London basin up to its northern boundary, where Cretaceous beds occur; and the greater part of the remainder of the area is formed by the London Clay, the exposure of the Thanet and Reading beds being very small. The surface is covered to a great extent with drift deposits of various kinds; but traces of the Red Crag are met with here and there in the north-eastern part of the area, especially in the neighbourhood of Sudbury. The memoir displays the usual accuracy and completeness characteristic of all work with which Mr. Whitaker has anything to do; but, good as it is, we do not understand why its cost should be quite so high—three-and-sixpence for a pamphlet of ninety-two pages, with nineteen woodcuts, will seem to unsophisticated people a little too much

WILLIAM HARVEY.†

HOW easy it is to depreciate; how hard it was to demonstrate the circulation of the blood; how incomprehensible it is to the multitude that scientific men should be so long in finding out such very evident things, are expressions which always must come forth on reading any life of William Harvey, and the criticisms of his contemporaries and successors. Poets, play-writers, and imaginative but not practical anatomists, had stated that the blood moved here and there, and that there was a circulation of it; but Harvey demonstrated the true circulation of the blood, and did not deal with fantastic imagery or a cyclical movment which, like that of Cæsalpinus, was not the true one. Why was the great fact that the arterial blood is propelled forth by the heart, and that it enters the veins by minute capillaries and returns, not found out before so late in the world's history? Its elaboration was opposed by the prejudices of mankind, by the pernicious

* "Memoirs of the Geological Survey, England and Wales. The Geology of the North-West Part of Essex and the North-East Part of Herts (explanation of Sheet 47 of the Map)." By W. Whitaker, W. H. Penning, W. H. Dalton, and F. J. Barnett. 8vo. London: Printed for Her Majesty's Stationery Office. 1878.

† "William Harvey. A History of the Discovery of the Circulation of the Blood." By R. Willis, M.D. London: C. Kegan Paul & Co. 1878.

domination of priestcraft, and by the want of the inductive and experimental method of reasoning. Like all great discoveries, it was led up to, and it was facilitated by the revolution in morals, religion, and method of thought which was proceeding. Dr. Willis places the ideas of the ancients and of those of the modern predecessors of Harvey most fairly before the world, and gives the proof that our great countryman not only taught the truth, but demonstrated it. Everyone before him had taught untruth, or only part of truth, and no one had demonstrated. Now, at the present day, scientific men do not acknowledge the imaginator as the discoverer, but the experimentalist, who proves and places a fact as a useful truth before the world. Everybody knows that Joule of Manchester demonstrated by experiment the mechanical equivalent of heat; but to Mayer we only owe thoughts on its possibility—the one is the discoverer, and to the other the world owes nothing. The Greeks progressed wonderfully in anatomy, and their great knowledge of the heart and vessels may be said to have culminated in Galenus of Pergamus, born 131 A.D., whose works ruled medical and anatomical science for thirteen centuries. Amongst the first of the modern imaginators, but who believed one kind of blood to be distributed by the veins for growth and maintenance, and another by the arteries, charged with heat and spirit for vital endowment, was Rabelais, and he certainly knew much anatomy. Sylvius followed and injected the arteries, but missed the significance of the obstructing valves in the veins. Winter of Andernach, the master of Vesalius and Servetus, demonstrated and described the valves of the heart, and noted the influence of the air on the blood in the lungs. Vesalius was a pure anatomist, but he considered that the motion of the blood was of a to-and-fro kind, and did not realise the importance or physiology of the venous valves. Persecuted by the Inquisition, he perished miserably in returning from a forced pilgrimage to Jerusalem. Servetus followed, and, strangely for the age, was a reformer in religion and a physiologist. He stated that the blood moved from the right to the left side of the heart through the lungs, in his work on the Restoration of Christianity, for which book he was burned by Calvin, the Protestant. He was aware of the peculiarities of the fœtal lung, and of its having no independent existence. Columbus (Realdus) described the vena portæ particularly, but denied muscularity to the heart. Eustachius discovered the thoracic duct in the horse, and its relation to the great venous trunk of the neck; and Fallopius intensified the belief that the veins were the distributors of blood, instead of the arteries. Sarpi, before his age in learning, was nearly assassinated by the orders of Paul V., but he did not add as much as did Arantius, who showed how the perfect closure of the heart's valves was produced. Then came Ruini and Cæsalpinus, neither of whom, however, were discoverers. Fabricius began the truth by demonstrating the presence and functions of the valves in the veins; and, finally, Rudius, knowing nothing of the function of the heart, and who believed that the pulmonary artery drew air into the left ventricle, (!) paved the way for Harvey, of Folkestone. His "Exercise on the Motions of the Heart and Blood" checked his professional prosperity, and all the "physitians" were against him; but in after years, and after the appearance of his "Generation of Animals," his brother physicians put up an inscription which gave him the credit for his great discovery. Dr. Willis describes the splendid work of this great man in a most readable and scholarly manner.

A MINISTRY OF HEALTH, AND OTHER ADDRESSES.*

THIS highly interesting volume contains upwards of nine addresses, written in the author's well-known style, and full of great and good thoughts. The first deals with the proposal to have a Minister of Health, and Dr. Richardson would make the appointment a permanent one, and it should be held by no party man. The next refers to William Harvey. A capital discourse on the inter-relationship of clerical and medical functions follows. In the chapter on Learning and Health there is an onslaught on needless competitions and the evils of the examination system. In the "World of Physic," pp. 209, 210, there is an awful but painfully true description of the oppositions to the aspirations and duties of the physician on the part of society; and the book closes with a very curious and suggestive chapter on the comparative merits of alcoholic and etherial drink. The work is like all those of the author—that of a man of genius, of great power, of experience, and noble independence of thought.

RAINFALL AND SUNSPOTS.†

UNDER the title of "Rainfall of the World," Mr. Archibald sends us a pamphlet comprising an essay, an introduction, and an appendix. In the introduction the author deals with solar energy, and assumes that this energy, being constant, is displayed at one time in the disturbance of the solar gases, as shown by the prominences and spots on the surface of the sun; at another in the maintenance of a high temperature; and concludes that the physical state in which the sun may be at any given time affects this earth by direct magnetic action, and by variations in the amount of heat radiated from the surface of the sun. The period of maximum intensity of one set of conditions is that of minimum intensity in the other. Years of minimum sunspot consequently show fewer magnetic storms, but higher temperatures, than years of maximum sunspots; and the author considers that the researches of numerous meteorologists, but more particularly of Köpper and Hahn, would appear to render the fact indisputable that periods of sunspot minima are those of maximum temperature.

As all meteorological phenomena are directly attributable to variations in temperature, through the winds which these variations occasion, the author in the essay divides the surface of the earth into five different zones, according to the winds, which are the vapour-bearing currents to each district. By dealing with each zone separately, according to its special local and geographical conditions, it becomes possible to explain away many apparent incongruities in the rainfall of different localities. Selecting from Zone II. the rainfall of Madras, a direct variation with the solar spot frequency is shown, and it is hardly possible to avoid connecting the regular variation of drought and plenty with the presence or absence of large numbers of sunspots

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* By Dr. Richardson, F.R.S. London: Chatto & Windus. 1879.

† "The Rainfall of the World." By E. D. Archibald. 8vo. Calcutta: Thacker, Spink & Co. 1878.

In Zone V., which embraces France, North Italy, Germany, and Russia, in those places where most of the rain occurs in the summer, the rainfall apparently varies directly with the sunspots; while in the case of the wet season, being the winter, the rainfall varies inversely, the very same changes in the physical state of the sun acting in totally opposite directions under the different conditions. It is evident, not only from a fact quoted by Mr. Blanford, namely, that the rainfall at Madras in 1860—a year of maximum sunspots—was lower than that for any other year between 1832 and 1867, but also from the author's own work, that it is impossible to look for any broad distinctive secular changes in the rainfall of the world, and that it will only be by minute research, and the elimination of local peculiarities, that the cyclical variations, if existing, will be discovered. In his appendix the author discusses the question of the relation between sunspots and cyclones.

SEWAGE POISONING.*

So many evils are due to the influence of sewage-gas escaping into our houses that we cannot but welcome every sensible suggestion that aims at keeping out so dangerous an inmate—a visitor, indeed, whose mere presence in a house is generally so disagreeable to the senses that it is a wonder people treat it with so much indifference. In a lecture delivered before a London Medical Society, and just published as a pamphlet, Dr. E. T. Blake discourses of the various diseases which may be traced, directly or indirectly, to the influence of sewer-gas, of which, as might be expected, he gives a sufficiently formidable list, pointing out especially that, besides those more acute affections which every now and then produce general alarm by their local prevalence and often fatal termination, there are a host of apparently less serious complaints which nevertheless are productive at least of much trouble and uneasiness, and by their long continuance cause serious injury to the health. By a description of the usual arrangements adopted for the conveyance of the sewage of our London houses to the main sewer, Dr. Blake shows how ingeniously these are contrived to facilitate the ingress of the deleterious gases, and, indeed, in many cases for enabling them to reach and accumulate in just those parts of the house from which they ought most carefully to be excluded; but having drawn this unpleasant picture, he does not abandon his readers to despair, but indicates pretty fully the course to be adopted in order to secure the exclusion of the unwelcome and mischievous intruder. Dr. Blake's pamphlet is illustrated with a series of woodcuts contrasting things as they are and as he thinks they should be, and there is no doubt that a great improvement in the sanitary state of our houses would be effected by the adoption of the rules which he has laid down.

* "Is Diphtheria Preventable?—Sewage Poisoning: its Causes and Cure." By Edward T. Blake, M.D. 8vo. London: Hardwicke & Bogue. 1879.

DOMESTIC POISONS.*

IT is a pretty well-known fact that certain bright green wall-papers contain a considerable quantity of arsenic, and that this deleterious substance is not so firmly fixed to the paper as to be incapable of detaching itself and floating about in the air as a poisonous dust. Of the ill effects produced by this dust there is abundant medical evidence; and from some observations it would appear that in certain cases, even when the arsenical compound is unable to break away in the solid form, an evolution of arseniuretted gas may take place and produce an equal amount of mischief. Mr. Henry Carr has collected a considerable body of evidence bearing upon this subject and other collateral matters connected with this insidious mode of introducing virulent poisons into our houses, and has published the results of his investigations in a small book, which certainly opens up a sufficiently alarming prospect. He finds that, contrary to the general opinion, the presence of arsenic is by no means confined to papers and other articles of domestic use of a bright green colour, but that many dull green articles are equally dangerous, and in fact that, thanks to the numerous modern applications of chemistry to the arts, a great number of colouring materials in common use contain arsenic, even when there is nothing green about them. The aniline dyes, for example, are not unfrequently contaminated by a residue of the arsenic used in their preparation. Mr. Carr cites a long list of things which may be rendered dangerous by the employment of poisonous dyes—articles of clothing, curtains, &c.—and cites a sufficient number of authorities to show that there is a grave reality in the charge he brings against many modern manufactures of domestic use. His main object is to call the attention of the public to the matter, with the view of obtaining legislative interference in the interests of public health.

ÆSTHETICS.†

ÆSTHETICS, like Social Science, is, it appears to us, so much in its infancy, notwithstanding the many writers on the subject, that it in fact has scarcely yet earned for itself the title of a science at all, for hardly any two writers appear to agree even as to its definition; and a science which is yet so crude that its very exponents hardly know what are the bases of the subject on which they write scarcely seems deserving of the name at all. M. Véron, however, gives his definition thus: "Æsthetics is the science whose object is the study and elucidation of the manifestations of artistic genius," which is certainly brief enough—and, as the author very justly remarks, avoids those "inconveniences and obscurities" into which others, who have perhaps endeavoured to give a juster, or at least a more detailed, definition have been led. As a treatise on Art, however, the book is ex-

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* "Our Domestic Poisons; or, the Poisonous Effects of Certain Dyes and Colours used in Domestic Fabrics." By Henry Carr. Sm. 8vo. London: W. Ridgway. 1879.

† "Æsthetics." By Eugène Véron. Translated by W. H. Armstrong, B.A. "Library of Contemporary Science." London: Chapman & Hall. 1879.

tremely interesting, and is one which may be taken up at any time for light and pleasant reading. It seems, however, unfortunate that in a book intended for the English reader all, or almost all, the illustrations are taken from French authors and artists, no mention being made throughout the book, unless we are much mistaken, even of such men as Hogarth, Reynolds, Gainsborough, Turner, and Ruskin. In the translation there is, it seems to us, one serious error: in a work translated from the French one does not expect to find such words or phrases as *bizarreries*, *en rapport*, *qui vive*, and many more, which are scattered through the book, while we cannot see any reason why "*Dieu me pardonne*" should be left in French in a quotation which, with that exception, is translated into English.

SCIENTIFIC SUMMARY.

ASTRONOMY.

Meteoric Dust.—Mr. Ranyard has contributed to the "Proceedings" of the Royal Astronomical Society a very interesting paper on the presence of meteoric dust in the atmosphere. Professor Andrews announced in 1852 that he had discovered particles of native iron in the basalt of the Giant's Causeway, and suggested that they may have been derived from meteors which fell when the basalt was in a plastic condition. In 1867, Mr. Phipson, in a book on meteors, said: "I have found that when a glass covered with pure glycerine is exposed to a strong wind, late in November, it receives a certain number of *black angular particles*, some three or four of which may be thus collected in the space of a couple of hours." These can be dissolved in strong hydrochloric acid, and produce yellow chloride of *iron* upon the glass plate." He adds: "Although I have made this experiment at various periods of the year, it is only in the winter months that the black particles giving, with hydrochloric acid, chloride of iron, have been met with." Towards the end of 1871, Nordenskjöld collected some apparently pure snow which fell in the neighbourhood of Stockholm during a heavy snowstorm, and on melting a cubic mètre of the snow he found that it left a black residue, from which he was able to extract with a magnet particles which, when rubbed in an agate mortar, exhibited metallic characters, and on being treated with acid proved to be iron. Nordenskjöld also found particles of magnetic iron in snow which he collected from off the ice of Rantajerwi, a spot separated by a dense forest from the nearest houses at Evoia, in Finland. The Arctic Expedition of 1872 led to results still more striking, black granules containing iron, phosphorus, cobalt, and probably nickel, being found in snow collected in spots very remote from human habitations. M. Tissandier has described the particles of solid matter found in deposits of dust on the towers of Notre Dame as resembling those which he was able to detach by friction from the surface of meteorites, and concludes "that they are the solidified metallic rain detached from meteoric masses during their passage through the atmosphere." Dr. Walter Flight published, in 1875, an important paper describing a kind of grey dust which he calls *cryoconite*, met with in holes in Polar ice, and forming a layer of grey powder at the bottom of the water filling the holes. He says: "The origin of cryoconite is highly enigmatical. That it is not a product of the weathering of the gneiss of the coast is shown by its inferior hardness, indicating the absence of quartz,

the large proportion of soda, and the fact of mica not being present. That it is not dust derived from the basalt area of Greenland is indicated by the subordinate position iron-oxide occupies among the constituents, as well as by the large proportion of silicic acid. We have, then, to fall back on the assumption that it is either of volcanic or cosmical origin! . . . Whencesoever it comes, it contains one constituent of cosmical origin. Dr. Nordenskjöld, extracted, by means of the magnet, from a large quantity of material sufficient particles to determine their metallic nature and composition. These grains separate copper from a solution of the sulphate, and exhibit conclusive evidence of the existence of cobalt, copper," and nickel (less certainly).

From evidence of this kind Mr. Ranyard infers that meteoric matter is continually falling in quantities which, in the lapse of ages, must accumulate so as materially to contribute to the matter of the earth's crust. He speaks of this theory, by the way, as one which has been advocated, for some time past, by Mr. Proctor. But this is not strictly correct. Mr. Proctor has advocated the theory that in remote past ages the earth has thus received material increments of mass, but not that meteors are now falling in such sort as to increase the earth's mass, even during many hundreds of thousands of years, in any appreciable degree. The total number of meteoric bodies falling annually on the earth's mass, from the largest aerolites down to the smallest shooting-star which an ordinary telescope would show (if the body chanced to pass across its field of view), has been estimated by Professor Newton, of Yale College, at 400,000,000. This only allows an average of two meteors per annum for each square mile of the earth's surface, or roughly about one meteor per square yard, in 1,500,000 years. As the average weight of meteors is probably to be measured rather by grains than by ounces, we cannot consider that the addition of one meteor per square yard would involve a very noteworthy increase of the earth's mass; and 1,500,000 years must be regarded as fairly equivalent to the time indicated by the rather vague expression, "the lapse of ages." In past times, however, when as yet the great bulk of the meteoric matter was still travelling freely around the sun, the rate of ingathering must have been far more rapid.

The Lunar Crater Hyginus.—Lord Lindsay and Dr. Copeland have made some interesting and instructive observations on the varying appearance of the region near Hyginus, confirming, as they point out, the well-known fact that this region "is full of complicated shallow irregularities and strongly-marked differences of tone, which tend together to produce great apparent changes of surface configuration, with change of illumination; and, further, to show that there exist striking features in the immediate neighbourhood which have hitherto escaped clear detection, but of which some traces may be found in the comparatively old map of Lohrmann." Their statements would hardly be intelligible, even to lunar students, without the drawings which accompany their paper. Let it suffice to observe, that they fully make out their case; and though their observations have no direct bearing on Dr. Klein's supposed recognition of a new crater in this region, yet indirectly they tend to increase the doubt with which the more cautious astronomers had received the announcement of the reported change. The facts collected also show, as Lord Lindsay and Dr. Copeland say, "with

what extreme caution all presumed evidence of change on the moon's surface ought to be received, and how necessary it is to accumulate observations made under various and particularly under *low* illumination."

The "Bedford Catalogue."—Admiral Smyth's Cycle of Celestial Objects, commonly called the "Bedford Catalogue," is used by so many telescopists, and has been so long regarded as an authority, that many will hear with pain as well as surprise of the announcement by Mr. Herbert Sadler, after careful examination of many statements in the work (vol. ii.), that it is utterly untrustworthy. He adopts and emphasizes the remark of that most careful and skilful observer of double stars, Mr. Burnham, that "no publication of original observations, in this or any other language, can be named which contains so many serious errors." "The measures of the Struves, Dembowski, Dawes, Secchi, and half a dozen others whose names might be mentioned," adds Burnham, "do not contain altogether more than a small fraction of the mistakes in the Cycle which have led to so much discussion and confusion. . . . Ordinarily there is no difficulty in detecting the mistake at once. This is not the case with the Cycle. There is no theory which will account for the many serious discrepancies. The measures generally agree substantially with those which are given from prior observers, but the strangest part is that the agreement is kept up just the same where the earlier measures are all wrong." This statement, it will be noticed, involves a somewhat serious charge, which those who are interested in supporting the reputation of the late Admiral Smyth would do well not to overlook. We shall hope to see the cases adduced by Mr. Herbert Sadler explained on some other hypothesis than that Admiral Smyth "fudged" (to use a schoolboy phrase) some of his observations. Not content with shaking our faith in this older catalogue, Mr. Sadler makes a most damaging reference to a catalogue published quite recently, at great expense, by the Royal Astronomical Society. "As far as I am aware," he says, "there is one catalogue only, and that not an original one, which surpasses the 'Bedford Catalogue' in inaccuracy, and that catalogue is the 'Reference Catalogue of Multiple and Double Stars,' forming Vol. xl. of the Memoirs." It is to be hoped that Professor Pritchard, who with the late Dr. Main shared the responsibility for the last-named most remarkable production, will endeavour to show that it is either not so bad as it is commonly reported to be, or that there is some valid excuse for its being, as many allege, altogether valueless.

Phenomena Observed at the Occultation of a Star by the Moon.—Mr. Christie describes a curious phenomenon presented at the occultation of the fourth magnitude star 17 Tauri by the moon, on November 10, 1878. He observed with nearly the full aperture of the Great Equatorial (nearly 13 inches). As the star approached the moon's limb he observed it steadily, fearing to lose it in the overpowering brilliancy of the moon's light. He expected it to disappear at a slight notch in the moon's bright limb; but instead of that the moon's limb, to his surprise, seemed to recede for some three or four seconds of time, and the star disappeared gradually in a sort of luminous haze, through which it was seen with more and more difficulty as it advanced. At the instant of disappearance the star was seen apparently perfectly bisected by the limb; that is, completely shorn of its rays and half

the diffraction disc on the one side (towards the moon), and intact on the other. The explanation given by Mr. Christie seems sound. "The star was not bright enough to be seen distinctly projected on the moon's disc, but was yet not so faint as to be overpowered by the irradiation at the limb. A spurious limb being formed by the superposition of diffraction images, the inferiority of light would increase gradually from the spurious to the true limb. At the former, the star's light overpowered that of the moon; at the latter, the moon's light overpowered that of the star." The circumstance that the diffraction image of the star was completely cut off on the side of the moon at the instant of its disappearance is strikingly confirmatory of this explanation.

A Strange Mistake.—Oddly enough Mr. Christie has allowed a remarkable mistake to appear in a paper which he edits. Messrs. Hirst and Russell, observing the moon at nine in the morning of October 21, the moon being then past her third quarter, imagined they saw a great circular shade (or rather part of such a shade) on the moon's face. Mr. Russell inquires into its possible nature, gravely discussing whether it may not have been the shadow of some unknown opaque globe, or of a very dense comet, between the earth and the sun. In reality the supposed shade was nothing but what can always be recognised when the moon is at that phase, the outline of certain dark seas forming in appearance, at that time, a part of a great circle having an apparent radius equal to nearly three-fourths of the moon's.

Phenomena for the Quarter.—Mercury will be in inferior conjunction with the sun on April 17, at 11 A.M.; at his greatest westerly elongation on May 15, when he will be 25° 40′ west of the sun; and at superior conjunction at midnight June 18. Venus is an evening star all through the quarter, her distance from the sun and her brightness increasing through the quarter, the former, indeed, not attaining a maximum till the middle of July, the latter not till the middle of August. The proximity of Mars and Saturn at the end of June will render these planets interesting objects to telescopists, though Mars will be far less brilliant than when he was in conjunction with Saturn in the autumn of 1877. At 8 P.M., June 30, the distance between the planets will not be more than one minute—a thirtieth, say, of the moon's diameter. But it will not be till a much later time of that night that the proximity of the planets can be favourably observed in England.

CHEMISTRY.

Conversion of Sugar into Alcohol by Inorganic Agents.—While considering the action of fermenting agents, Berthelot has been led to try an experiment which does not exactly solve the question of the conversion of sugar into alcohol by inorganic agents, although it throws some light upon that change. The hypothesis, to follow the consequences of which was of interest to him, was the following. If we assume that the action of a ferment consists in the breaking up into two complementary ingredients, of which the one contains the more oxygen, the other the more hydrogen—an action, in short, closely resembling that of potash on aldehyde—the two products will exhibit

a reciprocal activity. As, however, the energy consumed by the first decomposition cannot be again produced, the pristine sugar cannot be reproduced. In place of this the products suffer a new and deeper decomposition into alcohol and carbonic acid. Berthelot examined the condition of the simultaneous hydrogenation and oxidation of the sugar. A battery of six or eight Bunsen cells was employed, the poles of which were connected with an oscillating commutator which could be alternately positive and negative twelve to fifteen times in a second; and the electrodes were cylinders of platinum black. This apparatus, when immersed in acid water, evolved at each of the poles hydrogen and oxygen alternately. The apparatus was so regulated that it evolved no gas, the water being reformed at the moment after its decomposition. When placed in a watery solution of glucose, which was in some instances neutral, in others acid, and in others alkaline, alcohol was decomposed but only in very small quantities (some thousandths), the greater part of the glucose resisting the decomposition. So limited a change does not justify one in drawing conclusions. The production of alcohol in the cold, however, and by means of sugar, is a fact of great interest.—*Compt. rend.*, lxxxvii., 949.

The Chemical Composition of Sea-water.—Jacobsen has set himself the task of deciding the question whether the composition of sea-water taken from different seas and oceans, and different depths, possessed the same composition, and whether the discrepancies observed in analyses were due to errors of manipulation. For this purpose he examined the composition of forty-six specimens of sea-water, collected on board the "Gazelle" during the expedition of 1874–1876, for every possible locality and depth. The constituents which were determined were chlorine, sulphuric acid, and calcium carbonate. The chlorine showed only a very slight variation; the salt corresponding to the chlorine amounted in the highest case to 1·8140, in the lowest case to 1·8047, the mean being 1·80936. The chlorine was determined in fifteen specimens. When it is remembered that these results are influenced by the unavoidable errors of chlorine determinations and the determination of salt, one will not be disposed to ascribe to the found irregular variations any significance of weight, but will not hesitate to say that the relative amounts of chlorine contained in oceanic waters show no considerable variation. The sulphuric acid was determined in 166 specimens of water. It constituted in the mean 6·493 per cent. of the entire salt present; the greatest difference (0·35 per cent.) lay between the maximum 6·69 per cent. and the minimum 6·34 per cent. The author remarks that here again the variation would be less if the unavoidable error of the areometric determination of salt could be eliminated. There are grounds, however, for believing that the amount of sulphuric acid present in water is somewhat less constant than the amount of chlorine. On the other hand, attention must be directed to the fact that any regular variation in the properties of sulphuric acid, depending on the place or the depth from which the water has been taken, was not observed. The determinations of calcium carbonate were made in thirty-nine samples of water. The mean result was in 10,000 parts of water 0·269 parts of lime carbonate, the maximum being 0·312 parts, and the minimum 0·220 parts. So far from referring these variations in the results to differences in the sources whence the waters were taken, or regarding

them as indications of any other change, the author ascribes them to errors of experiment which became the greater in these cases from the fact of his having a more limited quantity of water to work with (less than one litre) than is desirable for experiments of these kinds. The results are very accordant when compared with the hitherto published analyses. They support the view held by the author that the amount of lime carbonate present in sea-water shows but slight variation. His results do not accord with those of J. Davy, who believed that the open sea contained little or no lime carbonate. And we are, moreover, not driven to believe the views pronounced by Forchhammer, that the sea animals which have shells are able to convert the lime sulphate of sea-water into carbonate. The waters of different regions appear to mix very rapidly and readily.

The Ammonia and Nitric Acid in Atmospheric Deposits.—In the year 1875 at the agricultural station in Munich, and in 1876 and 1877 at Tisis, near Feldkirch in Vorarlberg, W. Eugling made a number of determinations of these constituents in the rain, and the results are given in his report in Biedermann's "Centralblatt für Agriculturchemie," 1878. The amount of combined nitrogen appears from the results to vary considerably according to the locality where the rain was collected; the nitrogen compounds which are brought down to the soil in the immediate neighbourhood of large towns are probably considerably greater. And the amount which fell in the months when the rainfall was small was higher than in months when the aqueous deposit was more abundant. These results confirm those of Boussingault's researches. The average amount of the nitrogen in the precipitates which were collected in Tisis, while lower than that in the Munich deposits, is greater than that of Paris, where in 1858 Boussingault found 0·00163 gramme to the litre. In 1876 the average monthly yield at Tisis was 0·00320 gramme per litre, the maximum yield being in October 0·00620 gramme to the litre, and the minimum 0·00182 gramme per litre in April. In the year 1877, with the exception of September, the mean yield of ammonia was 0·00238 gramme per litre, the maximum being in November 0·00520 gramme, and the minimum in April being 0·00121 gramme per litre. In addition to this, it was found that the amount of nitric acid in 1876, with the exception of December, was in the mean 0·00192 gramme to the litre, the maximum being 0·00431 gramme in October, and the minimum 0·00085 gramme in January; and in the year 1877 the mean yield was 0·00160, the maximum in November being 0·00264, and the minimum in December 0·00092. In the case of Munich the mean for the month of March was 0·00366 gramme of ammonia and 0·00169 gramme of nitric acid per litre; and during April, on the other hand, 0·00414 gramme of ammonia and 0·00185 gramme nitric acid per litre. It was noticed that during those months when the ozone reaction was strongest the amount of ammonia, and nitric-acid-nitrogen were most nearly equal, which points to the conclusion, that at these times more ammonia nitrate and less ammonia carbonate are formed, not absolutely, but in relation to each other.

Formation of Felspars Artificially.—F. Fouqué and M. Lévy have communicated to the Academy of Sciences of Paris, the details of the process by which they have succeeded in preparing a suite of felspars, analogous to those which occur in eruptive rocks. They employ either natural porphy-

rised felspar or artificial mixtures of the chemical constituents, in short silicic acid and alumina, fused carbonate of potash and soda, and ignited carbonate of lime. The mixture is placed in a platinum crucible and heated to a temperature approaching that at which platinum melts in a Schloesing's furnace. The homogeneous mass thus formed, if suddenly cooled, is isomorphous; it must be placed without any delay in the flame of a Bunsen burner with a blast attached to it, and kept there for forty-eight hours at a temperature as little below the point of fusion as possible; and then, without any further precaution, allowed to cool in the crucible. Although the mass while fused occupies but little space, when heated with the blast it gives off bubbles and presents a porcelain-like appearance. Although the pocket-lens fails to detect the presence of crystals in this mass, the microscope shows the material to be made up of crystalline felspar. By this method Fouqué and Lévy have succeeded in preparing crystals of the three varieties of felspar which have the lowest fusing point, oligoclase, labradorite, and albite, in the forms in which they occur in eruptive rocks; and they hope in further experiments to prepare, not only the other simple varieties of this mineral, but the many combinations of them which are known.—*Compt. rend.*, lxxxvii., 700.

The Liquids Enclosed in the Cavities of Topaz.—T. Erard and A. Stelzner have examined the liquids in some cavities of topaz in the following manner. The microscope, the preparation, and a thermometer were all placed in a water-bath and so kept at an even constant temperature. The water was raised to a temperature of 30°, and after, in ten minutes, it had cooled to 28°, it was assumed that microscope, preparation, and thermometer had all the same temperature. The liquid enclosed in a cavity was now examined through the microscope, and warm water was slowly poured in as far removed as possible from the microscope, and carefully mixed up with the other water, while the other observer noted the temperature of the thermometer. When the liquid vanished, the apparatus was allowed to cool, and the return of the liquid observed. Seven cavities in two topazes from an unknown locality were examined. Each cavity contained two fluids; the individual point of limit of each at the lower temperature to which the preparations were exposed remained unchanged. The liquids always vanished suddenly, and their return in each of the seven cases was accompanied by violent boiling. It was found that for one and the same enclosure of the kind referred to the sudden disappearance of the liquid and its equally sudden return with the accompanying boiling took place at one and the same temperature, the difference in the observations, amounting to 0·03°, being evidently within the error of observation. The critical point was found not only to be somewhat different in the case of each preparation, but in the case also of the fluids contained in one and the same cavity. Although the sudden disappearance and return of the liquid took place at temperatures lying between 28°·745 and 29°·18, the fluid in no case can be pure carbonic acid, the critical point of which lies, according to Andrews, at 30°·92. As, however, Andrews has since shown experimentally that an admixture of permanent gases lowers the critical point of carbonic acid, it is probable that the so greatly expanding liquid contained in these cavities is a somewhat impure carbonic acid.—*Mineralogische und Petrographische Mittheilungen*, i., 450.

Contributions to Chemical Dynamics.—Dr. Wright and Mr. Luff have furnished a second report to the Chemical Society on some points in chemical dynamics, and containing an account of some further researches on the influence of time and temperature on the decomposition of metallic oxides by the three agents—carbon, carbonic oxide, and hydrogen. In their earlier report they studied the action of these three substances on ferric and cupric oxides, with the result that, for similar physical conditions of the reacting bodies, the greater the heat-evolution which occurs when the two substances react, the lower is the temperature at which the reaction commences. In the present report Dr. Wright and Mr. Luff investigate the action of carbon, carbonic oxide, and hydrogen on a number of additional metallic oxides, including those of manganese, lead, cobalt, and nickel. They arrive at the following conclusions. In the case of the oxides of iron and copper, which form two definite series of salts, the temperature of initial action of the reducing agents on the two oxides corresponding to these series of salts will be the same for each. This is in accord with the fact that the same amount of heat is evolved in the conversion of a given volume of oxygen into either of these oxides. In the case of the oxides of the metals —manganese, lead, nickel, and cobalt—which form superoxides, not corresponding with definite series of salts, and evolving oxygen on being heated, the temperature of initial action of a given reducing agent on the superoxide of one of these metals is sensibly lower than that of the same agent on the stable monoxide of the same metal. It is probable that this difference indicates that less heat is evolved when a given amount of oxygen unites with the metal to form the superoxide than would be the case if the monoxide was formed, which indeed is known to be the case in connection with one of these metals—manganese. It was also found that the temperature at which carbonic oxide commenced to act on any metallic oxide was invariably less than that required for hydrogen to react; whilst we learn that hydrogen commenced at a lower temperature than required by carbon. The connection which has thus been established between the amount of heat evolved during a reaction and the temperature at which the reaction occurs is a point of very great interest in chemical dynamics, and in the hands of the mathematician may lead to important light being thrown on the true nature of chemical combinations. It points in an obvious manner to an imaginable connection between the velocity of molecular vibration and the attractive force maintaining chemical union. This idea is strengthened by the remarkable fact to which the authors draw attention, that a long-continued exposure of the metallic oxide to the action of the reducing agent will develop a sensible chemical reaction at a lower temperature than will give rise to any action in a few minutes. It is to researches of this nature that we must look for a real extension of our present slight knowledge of the Dynamics of Chemistry.

The Yttrium Group of Metals.—In 1843 Mosander announced that Berzelius's yttria was really a mixture of three earths which he named yttria, erbia, and terbia, and he gave a short account of the characteristics of each base. Yttria was colourless and afforded colourless salts; terbia was also colourless, but gave pink salts; and erbia was dark yellow. Subsequently Berlin, and afterwards Bunsen and Bahr, worked on this subject, but were

unable to find more than two metals in this group which they termed yttrium and erbium (which was really Mosander's terbium). It was therefore generally supposed that there were only two metals in this group, and that terbium did not exist. Last year the subject was taken up by Marignac and anew by Delafontaine. In the early part of last year they both announced that they had found a third substance present besides yttrium and erbium, and agreeing well with the properties of the third metal of Mosander.

The new earth, terbia, is of a pure dark orange colour, but on being heated in a current of hydrogen, or at a high temperature in the open air, it becomes colourless. Its salts are colourless, and have no absorption spectrum. The atomic weight of terbium is 98·5 or 147·7 accordingly as terbia is considered to be a monoxide or sesquioxide. The atomic weight of yttrium and erbium are 58 and 114 (or 87 and 171 if these oxides are regarded as sesquioxides). Delafontaine now announces the presence of a fourth and fifth metal in this group which he has termed Philippium (Pp.) and Decipium (Dp.) respectively. The new metal, philippium, has an atomic weight of about 74 (or 111), and forms a yellow oxide and a series of colourless salts far more soluble than those of terbium, which when concentrated give a very intense absorption band in the indigo blue, a band not visible in the salts of yttrium, erbium, or terbium. The fifth metal, decipium, resembles didymium in its properties, but gives three remarkable absorption bands in the blue and indigo. Later, Delafontaine has been led to suspect the existence of a sixth metal of this group. In the meanwhile, Marignac has announced the discovery of yet another member of this group which he terms ytterbium (Yb). Both its oxides and salts are colourless, and are moderately easily soluble. They do not give any absorption spectrum. The atomic weight of ytterbium is about 115 (or 172·5 if the earth is a sesquioxide), or nearly that of erbium; but if the existence of this new metal be confirmed, it is probable that it will be found that Cleve and Hoeglund's determination of the atomic weight of erbium was vitiated by the presence of ytterbium, and that it ought to be below even Bunsen's value or about 104–5. Chemists will wait with some curiosity to learn whether further investigation confirms the existence of these numerous additions to the group of cerium and yttrium metals.

The Absorption Spectra of Organic Substances.—At the meeting of the Royal Society for January 9, 1879, a paper was read, by Messrs. W. Noel Hartley and A. R. Huntingdon, on the "Absorption of the Ultra-Violet Rays of the Spectrum by Organic Substances." The paper embodies a research which is likely to throw considerable light on the molecular constitution of the organic bodies. The normal alcohols of the fatty series are remarkably transparent to the ultra-violet rays of the spectrum; but there is an increased absorption of the ultra-violet rays corresponding to each increment of CH_2 in the molecule. The acids and the normal ethereal salts derived from the alcohols are highly transparent to the ultra-violet rays. When, however, the benzene derivatives came to be examined they were found to exert an enormous absorption on the extra-violet rays, and when dissolved in water they continued to show marked absorption bands even when very dilute. The isomeric bodies, containing the benzene nucleus,

exhibit widely different spectra, inasmuch as these absorption bands vary in position and in intensity. This widely different behaviour of the benzene and alcoholic compounds is a point likely to prove of service, as, for example, in the study of the constitution of the terpenes.

GEOLOGY AND PALÆONTOLOGY

Toothless Ichthyosaurus.—Those wonderful regions of the western territories of North America from which so many remarkable fossil forms have been derived show no signs of approaching exhaustion. Soon after the discovery of birds with true teeth had startled naturalists, remains of Pterodactyles were for the first time found in America, and these, following the example of the birds, reversed the accepted order of nature by exhibiting toothless jaws. Following up this remarkable series of discoveries, Professor Marsh now announces (*Amer. Journ. Science and Arts*, January, 1879) the occurrence in Jurassic deposits immediately below what have been described as the *Atlantosaurus*-beds, of the remains of a Saurian, presenting in most parts of its skeleton the characteristics of *Ichthyosaurus*, but *entirely without teeth*. He says "the vertebræ, ribs, and other portions of the skeleton preserved cannot be distinguished from the corresponding parts of *Ichthyosaurus*; and many features of the skull show a strong resemblance. The general form of the skull is the same. The great development of the premaxillaries, the reduced maxillaries, the huge orbit, defended by a ring of bony plates, are all present; but the jaws appear entirely edentulous and destitute even of a dentary groove."

The remains of this Saurian, which Professor Marsh names *Sauranodon natans*, preserved in the museum of Yale College, indicate an animal eight or nine feet long, of which the skull, which has the facial portion much produced, makes up about two feet. The orbits are very large, but the sclerotic ring consists only of eight plates, which are not arranged in a nearly flat ring, as in ordinary Ichthyosaurus, but form the basal segment of an elongated cone, as in the eyes of many birds.

Professor Marsh regards this curious creature as representing a special order of reptiles which he proposes to name Sauranodonta. It seems doubtful, however, whether the mere absence of teeth, either in this form, or in the toothless Pterodactyles, is a character of sufficient importance to justify the establishment of a new ordinal group.

Dolerophylleæ, a new order of Carboniferous Plants.—In April last Count Gaston de Saporta established a new genus of fossil Gymnosperms, under the name of *Dolerophyllum*, upon certain large conical buds formerly referred by Professor Göppert to the Musaceæ, and upon some leaves which were previously regarded as leaflets of *Nœggerathiæ* or of ferns. These leaves were allied to M. Grand-Eury's genus *Doleropteris*, which, in his opinion constituted, with *Rhacopkyllum* and *Aphlebia*, a group of plants wavering between *Nœggerathiæ* and ferns.

M. de Saporta and M. Renault have investigated these plant-remains, and according to the statements of the former (*Comptes rendus*, September 9,

1878, p. 373) they regard them as forming probably an order, Dolerophylleæ distinct from the Salisburieæ and Cordaïteæ, although specially allied to the latter through certain forms recently described in America by Professor Lesquereux. The leaves, which have generally been mistaken for leaflets of Neuropteroid ferns and described under the names of *Cardiopteris*, *Cyclopteris*, *Nephropteris* and *Aphlebia*, differ clearly in structure from those genera. They are simple, sessile, oval, or rounded, eared at the base, thick, encircled by a cartilaginous border, and traversed by numerous dichotomous nervures, which radiate from the point of attachment towards the margin and often bifurcate several times. The nervures were enclosed between two thick laminæ of epidermis, and are especially characterised by the abundance of gummous ducts, the true structure of which is not yet determined, but which accompany and surround the vascular bundles, often, when carbonised, forming filaments substituted for the true nervures which they conceal. This character recurs, although less strongly marked, in the Cordaïteæ. The insertion-scars produced on the stems by these leaves must have been rounded or transversely ellipsoidal, and such scars occur upon the stems of many so-called Calamodendreæ.

The reproductive organs ascribed to the Dolerophylleæ by M. Renault are very singular; and, while differing much from what are ordinarily observed in Phanerogamia, they indicate the existence of a series of plants in which fecundation was effected by means of corpuscles nearly agreeing, although of much larger dimensions and more complicated structure, with the pollen grains observed in the micropyles or pollenic chambers of several Palæozoic Gymnosperms.

Thus, according to M. de Saporta, the Dolerophylleæ represent in the Carboniferous flora, which was formerly supposed to be so predominantly cryptogamic, a new phanerogamic element; in fact, they were related to a whole series of prototypic phanerogams of which the Sigillarieæ probably also formed a part.

A Gigantic Triassic Reptile from the Cape.—Under the appropriate name of *Titanosuchus ferox* Professor Owen has lately described before the Geological Society a gigantic reptile belonging to his order Theriodontia, derived from the same South African Triassic beds which have already furnished him with so many remarkable and interesting forms of the same class.

He stated that among the fossils recently sent to the British Museum from the Cape of Good Hope by Mr. T. Bain there were two boxes containing specimens of a most unpromising character, there being in them no entire bones, but only numerous more or less water-worn fragments. Among these was found a portion of a maxillary showing some traces of teeth; and sections having been made of this bone, the remains of several teeth were displayed, including a canine, the preserved portion of the socket of which was 4½ inches long. From the number and mode of implantation of the teeth, he concluded that the animal to which they belonged resembled the Theriodont genera *Galesaurus* and *Galenops*. The anterior portion of the left ramus of the lower jaw, measuring 7½ inches in length, showed teeth presenting close analogies with those of Theriodonts, and this alliance was confirmed by the study of other fragments. Some of the characters presented by these remains seem to suggest affinities with the carnivorous mammalia,

such as have been already indicated by the humeri of Theriodonts and Carnivores.

The canine tooth of the new South African reptile was six times as long as that of the allied form *Lycosaurus*; and we have in *Titanosuchus* evidence of a carnivorous reptile of more carnassial type than *Machairodus* and other felines. The author suggests that *Titanosuchus* found its prey in the contemporary *Pareiosauri*, Oudenodonts, and Tapinocephalans of the same locality.

Submerged Forest on Bombay Island.—In Part IV. of the "Indian Geological Survey Records for 1878" is an interesting note on a submerged forest lately discovered on Bombay Island during the excavation for the Prince's Dock. The strata exposed in this excavation consist of some four to five feet of surface silt, superimposed upon a bed of dense blue clay, varying in thickness from 6 to 20 feet, but nearly level on the top; this clay rests upon loam and "moorum" (a local term for decomposed rock), the waste of the rock lying immediately below it. This rock is very irregular on its surface, and consists for the most part of indurated clay nodules imbedded in a hard matrix. It is between this rock and the silt at the surface that the submerged forest has been discovered. The trees grew in the loam and "moorum" in which their roots are found, apparently *in situ*, while the stumps penetrate into the blue clay above, some being in an erect and others in a more or less horizontal position; in no case, however, do they reach into the surface silt. "For a foot or so below the level of the blue clay the timber was riddled by *Teredo navalis*, or a similarly destructive worm," and a trunk was found to be charred on one side for a short distance. The largest trunk found measured 46 feet in length and 4 feet 8 inches in girth; and some of the timber, which is of a dark rosewood colour, with a straight grain, was quite sound. From the fact that the roots of these trees were found at a level of from low-water extreme tides to twelve feet below that line, Mr. Ormiston, the engineer, supposes that the land must have subsided at least thirty feet; but Mr. Blanford suggests that did the trees belong to such forms as *Avicennia* or *Bruguiera*, they might perhaps have grown in a salt-marsh, a supposition supported, he thinks, by the presence of *Teredo* borings in some of the stumps, and that, were this the case, it would materially affect the calculation of the depth to which depression has taken place.

Geology of Minorca and Majorca.—M. H. Hermite gives a description of the geological structure of these two little-known islands (*Comptes rendus*, December 30, 1878). Minorca is divided into two very distinct parts by a line running from N.W. to S.E., or from Mahon to Algairen. South of this line is an undulated plateau with deep ravines, formed of nearly horizontal calcareous strata which abut against the greatly raised strata of the northern region. The latter contains the oldest formations of the Balearic Islands, namely, about 1,000 mètres of grey or greenish schists and sandstones, showing vegetable impressions (*Calamites*), and having towards the middle of the system some calcareous deposits containing fossils belonging to the Middle Devonian. The upper portion of the schists and sandstones, therefore, probably represents a member of the Carboniferous formation. They are followed by fine-grained red or white sandstones with traces of plants, about

500 mètres in thickness and belonging to the Trias. The earliest Jurassic beds belong to the Middle Lias; these are followed by unfossiliferous limestones (sometimes dolomitic); and the uppermost Mesozoic deposits are whitish limestones with Neocomian fossils. All these strata are tilted at a high angle, and against them, as above stated, abut the Middle Miocene limestones which form the greater part of the southern region. Recent calcareous deposits containing *Helix vermicularis* and some fragments of marine fossils attain to a considerable extension, and rest indifferently upon the Miocene and older beds, indicating a great descending movement at the time of their formation.

In Majorca the oldest deposits are red sandstones (Trias), and these are met with only at one spot on the coast. Above these there is the same succession of formations as in Minorca; but the Middle Lias fossils are only found in a few localities. Above this are about 400 mètres of limestones, generally unfossiliferous, which probably represent a great part of the Jurassic strata; at the Puiz de Lope ammonites occur which seem to indicate the presence of the Oxfordian; and the series is crowned by limestones containing Cephalopoda, which indicate the horizon of *Ammonites transitorius*. The Neocomian is greatly developed, and contains a fine fauna. If the older beds are wanting, the Tertiaries, on the contrary, are much better developed than in Minorca. The lowest stage of these is a lacustrine limestone with beds of lignite at its base in some places, which the author regards as of Lower Eocene age; it was thought to be supra-nummulitic by Haime, but is overlain by the Nummulitic limestones. The lake in which these deposits were thrown down was more than 80 kilomètres in its longest diameter.

The Stonesfield Mammals.—It has long been known that in the so-called "Stonesfield slate" of Oxfordshire, a part of the Lower Oolite formation, the remains of mammalia occur; in fact, four species, belonging to three genera, are recorded by Professor Owen. Of these, the most ancient mammals after the *Microlestes* of the Keuper of Württemberg, which is known only from teeth, the only traces hitherto described have been the lower jaws. Professor Seeley has announced to the Geological Society (February 21, 1879) his discovery, in slabs of Stonesfield slate which have been preserved for many years in the British Museum, of two small bones, which, on examination, were found to present mammalian characters. These are a femur and a humerus; and as they nearly correspond in size, and there is no evidence to the contrary, Professor Seeley preferred to regard them provisionally as belonging to the same species, and from their characters he was inclined to associate them with the jaw described under the name of *Phascolotherium*. They are considered by him to indicate a special, probably insectivorous, monotreme type, with marsupial tendencies, such as, on the hypothesis of evolution, might well be supposed to occur early in the history of the mammalia. It is to be hoped that the detection of these interesting remains may lead to a careful examination of the slabs from Stonesfield which exist in many museums, and that the search may be successful.

Conodonts.—The curious minute fossils described by Pander under the name of Conodonts, and regarded by him as probably the teeth of fishes of very low organisation, have been detected in great abundance by Mr. G. J. Hinde in rocks of the Chazy and Cincinnati groups of the Cambro-Silurian,

and of the Hamilton and Genesee-Shale divisions of the Devonian in Canada and the United States. In a paper read before the Geological Society (March 12, 1879) that gentleman described a great number of forms of these bodies, including most of those figured by Pander from Russian Silurian rocks, and some not previously met with. In the Chazy beds they are associated with numerous Entomostracan crustacea of the genus *Leperditia*, a few trilobites, and some gasteropods; in the Cincinnati group they occur with various fossils; and in the Devonian principally with fish-remains; but none of the associated fossils furnish any clue to the true nature of these problematical bodies. Mr. Hinde regards their zoological relationship as very doubtful, but they most resemble the teeth of Myxinoid fishes.

Fossil Remains of Annelids.—At the same meeting of the Geological Society Mr. Hinde described numerous jaws of annelids which he had obtained from Cambro-Silurian, Silurian, and Devonian rocks in Canada, and from the Lower Carboniferous of Scotland. The existence of annelids during the deposition of the older rocks has hitherto been evidenced chiefly by the occurrence of their trails, and of a few impressions of their bodies; the former being a very uncertain ground, seeing that in some cases, at any rate, the supposed annelid-trails have been proved to be the tracks of crustaceans. Of the nature of the fossils described by Mr. Hinde, chiefly obtained from shallow water deposits, no doubt could be entertained; he showed their close resemblance to the jaws of existing annelids, and indeed was enabled from these resemblances to refer them to well-known families. Mr. Hinde enumerated fifty-five different forms of these minute bodies, mostly from the Cincinnati group of Canada; and classified them under seven genera, five belonging to the family Eunicea, one to the Lycoridea, and one to the Glycerea.

MICROSCOPY.

Method of Investigating the Embryos of Fishes.—M. Henneguy has communicated to the Philomathic Society of Paris the description of a method of preparing the embryos of fishes and other similar objects for microscopic purposes. He places the ovum for a few minutes in a 1 per cent. solution of osmic acid until it acquires a light brown tint, and then in a small vessel containing Müller's liquid, in which he opens it with fine scissors, when the central vitelline mass dissolves at once in the fluid, and the solidified germ can be extracted from the ovum for examination. By treating the germ with a solution of methyle-green and then with glycerine he has been able to observe in the cells of segmentation those very delicate phenomena which have been lately described by Auerbach, Bütschli, Strasburger, Hertwig, and others, proving that the treatment to which the ovum had been subjected did not alter the elements of the germ.

For the purpose of making cross-sections of the embryos, M. Henneguy leaves them for some days in Müller's liquid, and colours them with picrocarminate of ammonia. He then treats them with alcohol of spec. grav. 0·828, and afterwards with absolute alcohol to free them from water, and soaks

them for twenty-four hours in collodion. Each embryo is then arranged upon a small plate of elder pith soaked in alcohol and covered with a layer of collodion, and when the latter has arrived at the proper consistency very thin sections may be made through the embryo and the pith. They are to be preserved in glycerine. The process has the advantage of enabling one to see the precise point at which each section is made, and there is no occasion to free the sections from the collodion which encloses and holds them in place.—*Ann. and Mag. Nat. Hist.*, March, 1879.

Preservation of Infusoria.—M. A. Certes has communicated to the French Academy of Sciences (*Comptes rendus*, March 3, 1879) an account of a process which he describes as very successful in the preservation of the Infusoria.—He says that the preparations exhibited in illustration of his note showed "various species of Infusoria, fixed instantaneously in their form: the smallest details, cilia, cirrhi, flagella, buccal armature, can be observed under the highest powers; the green *Euglenæ* and *Paramecia* retain their characteristic colour. The nucleus and nucleolus, coloured artificially, stand out clearly, and show, when these occur, the curious phenomena so well described by M. Balbiani" in 1862. A process offering such results as these is worth knowing; the following is the author's account of it.

For the fixation of the Infusoria he employs osmic acid, either in the form of vapour, or in a solution containing two per cent. of the acid. In the former case the Infusoria placed upon a glass slide may by exposed to the vapour for from 10 to 30 minutes. With very contractile species he places a drop of the solution on the covering glass, before placing it upon the drop of water containing the animalcules. The excess of liquid under the cover is then removed by means of blotting paper, and thus a slight pressure, said to be advantageous, is produced upon the specimens. Two opposite sides of the thin glass are then luted down either with paraffine or with Canada Balsam, and the preparation being thus secured against displacement, the colouring material and the preservative may be introduced. M. Certes mentions soluble aniline blue and eosine as colouring agents, but gives the preference to Ranvier's picrocarminate of ammonia, which he employs combined as follows:

Glycerine	1 part.
Water	1 „
Picrocarminate	1 „

In the introduction of glycerine the author follows the method recommended by Ranvier in his "*Traité d'Histologie.*" He places in a damp chamber the preparations fastened as above described, and puts a drop of the coloured glycerine on the edge of the covering glass. The water evaporates very slowly, and in twenty-four hours the film of water between the glasses is replaced by dilute glycerine, which may in its turn be replaced by concentrated glycerine by the same process. The best varnish for closing these preparations according to M. Certes is dry Canada Balsam dissolved in chloroform.

PHYSICS.

Acoustic Vibrations Caused by Heat.—Lord Rayleigh, in a recent lecture at the Royal Institution, drew attention to some forms of this phenomenon.

After briefly naming Trevelyan's Rockers, Sondhauss's experiment was shown, in which, when a bulb about three-quarters of an inch in diameter is blown at the end of a narrow tube 5 or 6 inches long, a sound is heard proceeding from the heated glass. The original observer showed that the vibration of the glass itself is no essential part of the action.

If a closed tube, hot at the closed and cool at the open end, be considered; if the adjustment of temperature were instantaneous, heat would have no effect in producing vibration. But as it takes time, it follows that at the phase of greatest condensation heat is received by the air, and at the phase of greatest rarefaction is given up from it, so that there is a tendency to maintain the vibrations. A great range of temperature is necessary for the maintenance of vibration, and the transfer of heat is unfavourable at the closed end, where the motion is small. Hence, probably, the advantage of the bulb.

The sounds emitted by a jet of hydrogen burning in an open tube are in a measure due to the column of gas in the tube which supplies the jet. If this be plugged with cotton, no sound can be obtained.

When a piece of fine metallic gauze stretched across the lower part of a tube open at both ends and held vertically is heated by a gas flame placed under it, a sound of considerable power, lasting for several seconds, is observed almost immediately after the removal of the flame. It seems to be due to a draught impinging on the heated gauze.

A complementary phenomenon was discovered by Bosscha and Ries. If a current of hot air impinge on cold gauze, sound is produced, but, to obtain the principal note, the gauze must be in the upper, not in the lower half of the tube.

On the Anatomy of the Organ of Hearing in relation to the Principle of the Microphone.—Dr. J. D. Macdonald, F.R.S., very ingeniously points out the similarity in principle between the vibrating particles of the microphone and the otoconia and otoliths in Pteropods, and others of the lower animals. Even the malleus and incus in the human ear "correspond not only in figure, but also in function, to the objects from which their respective names are derived, answering very important ends in the faculty of audition." Dr. de Chaumont notes the influence of moisture as in Mr. Blyth's experiments. The *otoconia*, *endolymph*, and *vestibule* of the ear present a complete type of a microphone.

The Electrical Gyroscope.—The value of the gyroscope as a means of showing the earth's rotation independently of any astronomical observation, seems hardly to have been appreciated. This, and another noble experiment for the same purpose by means of a long pendulum, are due to the ingenuity of the late Mons. Foucault. The latter was freely demonstrated at the time of its first announcement in many of our large public buildings, especially in the Radcliffe Observatory, at Oxford. Its simple relation to the sine of the latitude of the place of observation renders it the more valuable. But hitherto there has been some difficulty in showing the more compact form of the same physical law which the gyroscope furnishes. Mons. Foucault himself attained the necessary end of a durable rotation of the heavy disc by means of excellent mechanical construction and the avoidance of all unnecessary friction. In the Loan Exhibition at South Kensington one of his original

instruments lay unheeded in a dark and solitary corner. Had this ill-used and ill-appreciated nucleus of an English *Conservatoire des Arts et Métiers* continued longer, this and many other historical instruments of inestimable value, would in time have received due attention.

The disc was furnished with a small driving pinion, and being removed from its delicate suspension, was dropped on the top of a vertical mill or driving apparatus of multiplying wheels, terminating in a handle. It was thus whirled up to a high velocity, and then gently lifted off the driving apparatus into its position of suspension. The rotation thus imparted could be sustained for above an hour, and even more in a fair vacuum. But from the first it was essentially moribund; and it is only recently that an attempt has been successfully made to render it self-supporting. The machine consists essentially in a wheel of very heavy rim, freely supported on screw points. If the frame in which the wheel turns be itself suspended in a second frame, so that the axis is unconstrained, the position of original rotation will be maintained independently of the motion of the earth. The effect of gravity in tending to keep the disc in a fixed position, relative to the earth's surface, is in fact annihilated. A hand fixed to the frame in which the wheel revolves will move over a divided circle attached to the base of the instrument with an angular velocity equal to 360° multiplied by the sine of the latitude of observation.

It has been ingeniously suggested to apply this motive power by means of electricity. Clockwork and weights or springs are evidently inadmissible. Mr. G. M. Hopkins has overcome constructive difficulties, and rendered the instrument of great practical value.

The disc carries a soft-iron armature close to the face of a small electro-magnet included in the frame. An insulated contact-spring is arranged to touch twice during each rotation, and to cause attraction of the armature. One battery connection is made through the supporting pivot, the other by means of a wire dipping in a ring-shaped mercury cup. Two or three Bunsen's cells are sufficient to maintain rotation at the necessary velocity.

Dilatation by Electricity.—Mons. Duter drew the attention of the *Académie des Sciences* to the fact that when a Leyden jar is formed of a long tube, encased in tinfoil, and filled with water or a saline solution, on its receiving an electrical charge the level of the contained fluid sinks appreciably; on discharge it instantly resumes its former level. The natural conclusion is, that the glass of the jar dilates. This phenomenon occurs whatever be the nature of the armatures, foil, water, or mercury. If the jar thus formed be placed in an outer tube containing fluid, and acting as an outer coating, the latter ascends, while the former sinks. On discharge they both return to their former level. It is, therefore, obvious that internal capacity and external volume increase during the charge of a Leyden jar. The phenomenon cannot be due (1) to rise of temperature, as it suddenly disappears on discharge; nor (2) to electric pressure, which, being the same on the two faces of the dielectric, would tend to diminish its volume; nor (3) to the superior attraction of the electrified jar for the liquid, since it ought, in this case, to sink in the outer jar also; nor (4) to differences of the positive and negative armatures, for if the communications be reversed the direction remains unchanged. The cause seems to be unexplained.

The Microrheometer.—Mr. J. B. Hanway gives the above name to an instrument for measuring the phenomena of the flow of liquids through capillary tubes, which has been termed "transpiration," a word already applied to a totally different process occurring in gases, but for which he proposes to substitute the term "microrheosis," which has the defect of being somewhat hazy in its etymology. The apparatus is so arranged that when the liquid is introduced the pressure and temperature, as well as the atmosphere in which the experiment is conducted, may be varied, while the thermometer is at the mean point of the system. The determination of the relation between the chemical composition of a liquid, as well as its temperature and its rate of flow through a capillary tube, was originally worked out with great accuracy by Poiseuille as regards pressure and dimensions of tube. In examining saline solutions he used percentages instead of equivalent values of the body dissolved, and in consequence could make nothing of the numbers arrived at. Water runs about five times as quickly at 100° C. as at 0°. Mr. Hanway gives a curve for water from 0° to 100°, the differences of rate being smaller as the temperature rises.

In saline solutions the rate of flow does not depend on any of the mechanical features of the salt, such as crystalline form, specific volume, solubility, &c., but on the mass of the elements forming the substance, and the amount of energy expended in its formation. Each element has a value of its own, which is continued in all its compounds. The greater the combining value of an element the higher its rate. The flow also varies with the amount of energy in the compound; thus nitrates stand highest, then chlorides, and lastly sulphates.

Measurement of Powerful Electric Currents.—Mr. John Trowbridge, of Harvard University, contributes a paper on this subject to the American Academy of Science. He divides the methods into four—1, the galvanometric; 2, the electrometric; 3, the thermal; and 4, the electrodynamometric. No. 1 requires the galvanometer to be shunted by a wire of very small resistance. Any error in measuring this small quantity, and any heating of the shunt itself, multiply the whole observations by these errors; indeed, a large quantity is measured by operating on a small fractional part, the hundredth or the thousandth part of itself. Method No. 2 takes the difference of potential of two points in a closed circuit, and is liable to leakage and want of constant charge in the electrometer. No. 3 depends on the law that the heat developed in a circuit $= C^2Rt$, and C can be deduced from measuring the rise of temperature in a given volume of water. It is liable to errors of conduction, radiation, and of thermometers.

Method No. 4 employs Weber's well-known electrodynamometer, consisting of a movable coil hung from a bifilar suspension which conducts the current, between fixed coils on either side of the movable one. But such an instrument, as ordinarily constructed, would be quite incompetent to convey the large currents to be tested without heating and disorganisation. Shunts, as above stated, are to be avoided.

The instrument actually used is described. The large fixed coils are of copper band, thirty-five mm. broad and one mm. thick, in six turns each, insulated with vulcanite, and left their own thickness apart, so as to allow a free circulation of air. The current was not sent through the bifilar suspen-

sion, which could, therefore, be made of silk. The movable coil is at the centre of a rod carrying at the top a mercury cup, and dipping into another by its lower point. Both these were kept cool by a free circulation of water, as in the "tuyères" of a blast furnace. No difficulty from heating was experienced even with currents of 80 Webers. The resistances were large bands of German silver of the value of 1-10th of an Ohm.

With this apparatus the Wilde, Gramme, and Siemens machines were compared, with the result of placing the Gramme first, the Siemens second, and the Wilde third in efficiency, although theoretically the Siemens should give the best result; but it suffered the disadvantage in these experiments of being run at a less speed than the others.

Absolute Pitch.—An ingenious method for determining this was recently brought before the Musical Association by Lord Rayleigh. It depends on the principle that the absolute frequencies of vibration of two musical notes can be deduced from the interval between them, i.e., the ratio of their frequencies, and the number of beats which they occasion in a given time when sounded together. For example, if x and y denote the frequencies of two notes whose interval is an equal temperament major third, we know that $y = 1{\cdot}25992x$. At the same time the number of beats heard in a second, depending on the deviation of the third from true intonation, is $4y - 5x$. In the harmonium these beats are readily counted with the aid of a resonator tuned to the common overtone, and thus are obtained two equations, from which the absolute values of x and y may be found by the simplest arithmetic.

This method is not, however, practical in the case of the harmonium, in consequence of the pitch not being sufficiently constant, even when the blowing is carefully conducted with the aid of a pressure-gauge, the slightest change of interval being fatal to success.

It is, therefore, necessary to be able to check the accuracy of the interval supposed to be known, at the same time that the beats are being counted. The equal temperament whole tone is intermediate between the minor and the major tone, lying nearer to the latter. Regarded as a disturbed major tone, it gives slow and, as a minor, comparatively quick beats. Both can be heard at the same time, and, when counted, give the means of calculating the absolute pitch of both notes. If x and y be the frequencies of the notes, a and b those of the slow and quick beats—

$$9x - 8y = a$$
$$9y - 10x = b$$

whence

$$x = 9a + 8b$$
$$y = 10a + 9b$$

This method in no way assumes the truth of the equal temperament whole tone. Four experiments are given in detail. The author believes that very accurate results might be obtained by the introduction of certain modifications. It is, however, impossible for one observer to count both sets of beats at the same time, or even one, without the aid of resonators.

Further attempts at accuracy would be useless, for the cause above named, unless the comparison with a tuning-fork were simultaneous with the other observations; and more observers would thus be required.

Reflection and Refraction.—Within the last few years Professor J. Clerk-Maxwell has shown the possibility that all electrical phenomena are due to pressures in the same ether, and this has long been assumed as the means of the propagation of light. Acting upon this assumption, he has deduced what the laws of transmission of light in ordinary crystalline and magnetised media would be, and from such deductions he arrived at the laws of these phenomena. In a paper recently read before the Royal Society, Mr. G. F. Fitzgerald, F.T.C.D., investigates the laws of the reflection and refraction of light upon the same assumption, and he has obtained the same results as Professor M'Cullagh long ago deduced from his theory, and which are known to represent almost exactly the laws of reflection and refraction at the surfaces of ordinary and crystalline media. Still further, he investigated the laws of reflection at the surfaces of magnets, with theoretical results which essentially agree with and completely confirm Mr. Kerr's recently published experiments on the reflection of light from the pole of a magnet.

The Magic Mirror of Japan forms the subject of a communication recently made to the Royal Society by Profs. Ayrton and Perry.

Its distinguishing property is that of "apparently reflecting from its polished face the raised characters on its back."

The mirror is of bronze, convex, polished with a mercury amalgam, and bearing at its back a raised design.

Sir Charles Wheatstone, in 1873, appears to have noticed the instrument, supposing that the maker "scratched a pattern on the surface, which, after being polished, showed no traces of the scratches when looked at directly; but when used to reflect the sunlight on to a screen revealed the pattern as a bright image."

As early, however, as 1832, Mr. Prinsep had given an account of the mirror in the "Journal" of the Asiatic Society of Bengal, concluding that "the thin parts are slightly convex with reference to the rest of the reflecting surface," and thinks it probable that "part of the metal was by stamping rendered in a degree harder than the rest, so that in polishing it was not worn away to the same extent."

Various explanations had been offered by Mr. Highley, Sir D. Brewster, and others. Even the Roman writer Aulus Gellius appears to have been acquainted with the instrument.

The authors of the paper saw that the employment of beams of light of different degrees of convergence or divergence would furnish a test for deciding the cause of the whole action. Molecular differences of surface would be practically independent of these factors; whereas if the effect were due to portions of the surface being less convex than the rest, a complete inversion of the phenomenon might be expected to take place under proper conditions. This was found to occur.

The method of producing this distortion by means of an iron rod is explained at length.

Self-luminous Clock Dials.—Dr. Henry Morton, President of the Stevens Institute of Technology, publishes interesting details on this subject. He has made an analysis of the substance with which the dials are coated, and found it to consist of the well-known phosphorescent compound, sulphide of

calcium, attached by means of some resinous medium, like varnish. While the material is far from novel, its method of manufacture and consequent condition give it such intensity as has never been approached before. The light given out is a violet-blue, like that which Becquerel produced with arragonite. Some portions glow by phosphorescence much more brightly than others; evidently this difference depends upon small structural or molecular variations. If further advances be made in this direction wonderful results may accrue. Thus, if walls were painted with such a substance they would absorb light enough during the day to continue luminous all night, and render all sources of artificial light useless. The colouring of houses on the outside with a like material would also evidently obviate the need of street-lamps. He does not expect that this remarkable and economical source of light will displace gas and all other sources of artificial illumination, but this new form of the phosphorescent sulphide of calcium, made of the cheap materials sulphur and lime, is a truly wonderful substance, which may well suggest strange possibilities for the future. In the cabinet of the Stevens Institute are numerous specimens of phosphorescent powders—sulphides of calcium, barium, and strontium—which represent the best products heretofore obtained. These, if exposed to strong sunlight or to an electric discharge, will glow for many minutes in the dark. One of these clocks, however, he found, would continue to glow with sufficient brightness to be visible across a room all night, and could be read at any time, if approached closely. After being shut up in a box for five days this clock was still visible in total darkness, when the eyes had been rendered sensitive by remaining in the dark for a few minutes. This clock-dial is also readily "excited" by lamplight or gaslight, or indeed by any source of light containing rays above the yellow of the spectrum. The light from a Bunsen burner with soda in the flame, if filtered through yellow glass, will not excite it, but the blue rays of the Bunsen-burner flame will. The cause of the action is believed to be somewhat as follows:—When light falls on certain bodies its vibrations cause molecular changes which are not permanent, but are only maintained by the action of the "exciting" vibrations, somewhat as a mass of plastic substance can be kept in a soft condition by constant stirring. When the exciting cause is removed the molecules return to their normal positions, and in so doing set up vibrations which are the cause of light, very much as the solidifying of water evolves heat. Thus these bodies, when exposed to daylight, absorb as it were the light energy, and re-emit the same afterwards. The phosphorescent property of sulphide of calcium has been known since 1768, when Canton prepared it by heating together intensely for an hour three parts of calcined oyster-shells and one part of sulphur. Its properties in this relation have been elaborately studied by Becquerel, who published his researches in the "Annales de Chimie et de Physique," and has also devoted a large part of the first volume of his book, "La Lumière," to this subject. He found that by employing lime in different forms, such as Iceland spar, marble, oyster-shells, arragonite, &c., products emitting different colours by phosphorescence, such as orange, yellow, green, blue, and violet, were obtained.

Collimator Adjustment.—Mr. A. Schuster suggests to the Physical Society a simple means of adjusting the collimator of the spectroscope; the ordinary

process of focussing the telescope to a distant object, and the collimator to the focus so obtained being only applicable to the mean rays, and useless with quartz lenses and ultra-violet undulations. It consists of consecutive approximations. If the collimator be out of adjustment, there will be two positions of the prism, one on either side of the minimum deviation, which will bring the desired ray into the field (A and B).

In position A the telescope is to be focussed to distinctness; in position B, the collimator. After three or four trials no change of focus is required, and the adjustment is made.

Theoretically, the method requires absolutely plane faces to the prism, which are difficult to obtain; but practically the change of adjustment thus required is very small, not amounting to more than one-half per cent. for an exceptionally bad specimen.

The Acoustics of Auditoria.—Mr. W. W. Jacques contributes to the Journal of the Franklin Institute some facts of considerable value on this neglected subject.

The first is a laboratory investigation into the effect of currents upon a ray of sound; the second and third studies, by different methods, of the effects of currents of air in a hall or theatre upon the waves of sound.

At a point A was placed a source of sound, and at E the ear. Between these were placed substances heated so as to produce currents of air corresponding in density to those found in an auditorium. With a small leaden organ-pipe the intensity was increased, but the distinctness impaired. The same effect occurred with a clear voice, accompanied by a sensation of repetition. On the violin the effect was less, and with a drum *nil.*

In the second experiment the sound-waves were actually traced out in space, and their confusion consequent on introduced currents of air demonstrated. A platform 6 feet wide and 12 feet long was set on end in a room 92 feet long by 65 feet broad. On one side was a B_4 stopped organ-pipe, blown with a constant pressure of air.

Within the sound-shadow of this screen a system of co-ordinates, in a plane parallel with the floor, was set up by means of light rods divided into centimètres.

It had been shown by the author that rays of sound diverging from such a source, diffracted round the edges of the screen, on meeting after having passed through paths differing by half a wave-length, will neutralise each other and produce comparative silence. By moving an unison resonator along these co-ordinates the points of interference are easily detected, and are found to be situated as those of the diffraction of light. This was done in a closed room with still air. The doors and windows were then thrown open, and stove registers allowed to admit streams of air at nearly 100° C. The diffraction phenomena instantly disappeared.

The theory thus corroborated was applied to the Baltimore Academy of Music, which is specially arranged to prevent the formation of air-currents of unequal density. The whole supply of fresh air is admitted at the back of the stage, warmed, and led across it to the proscenium diagonally towards the roof, passing into the ventilating tower over the great chandelier at the rate of about 15,000 feet per minute. The room is singularly easy to speak and sing in.

Experiments were made by reversing the ventilating valves, and these showed distinctly that good or confused hearing depended very materially on the amount and direction of the air-currents circulating in the area.

Electromagnetic Rotation of the Plane of Polarisation in Vapour of Sulphide of Carbon has been investigated by Kundt and Röntgen. Faraday failed to detect this phenomenon in gases generally. An iron tube was closed at the ends by glass plates and surrounded with a steam-chamber. This latter was enclosed in six large coils of wire traversed by the current from sixty-four large Bunsen cells. The temperature was then raised to that of boiling water, and a pencil of polarised light was extinguished by a Nicol's prism as analyser. On passing the current the field brightened distinctly, and still more by commutation of the current. This rotation followed the direction of the positive current, and amounted to about 30′ of arc.

The same rotation was afterwards observed in gaseous sulphurous acid at 100° C., and at a pressure of twenty atmospheres; also in sulphuretted hydrogen at the same pressure, and at the ordinary temperature. Air up to twenty-five atmospheres gave no results.

Velocity of very Loud Sounds.—Mr. W. W. Jacques communicates some experiments on this subject to "Silliman's Journal," from which it appears that—

(1) The velocity of sound is a function of its intensity.

(2) Experiments in which a cannon is used contain an error, probably due to the bodily motion of the air near the cannon. A low musical sound should be used for determinations of velocity.

A Current Regulator.—Dr. Siemens brought before the Royal and Physical Societies an instrument of this character, depending for its action on the heating effect of the current. In the earlier form of apparatus a fine strip of metal, rolled very thin, was attached at one end to a rigid support, carried over a pulley, and fixed at its other extremity to a lever connected with a series of contact pieces joined to resistance-coils.

In the later form a similar strip of mild steel was stretched across the bottom of a cylindrical box, carrying in the middle a sliding bar or pin resting by its end vertically on the strip. According to the expansion of the strip by the heat of the current, the pin is depressed or elevated, and a circular series of short resistance-coils is introduced one by one into the circuit. The included resistance is thus increased by a rise and diminished by a fall of temperature in the sensitive slip. Dr. Siemens, in describing this compensating action, said: "Suppose that the current intended to be passed through the instrument is capable of maintaining the sensitive strip at a temperature of, say, 60° C., and that a sudden increase of current takes place, in consequence either of an augmentation of the supply of electricity, or of a change in the extraneous resistance to be overcome, the result will be an augmentation of temperature, which will continue until a new equilibrium between the heat supplied and that lost by radiation is effected. If the strip is made of metal of high conductivity, such as copper or silver, and is rolled down to a thickness not exceeding 0·06 mm., its capacity for heat is exceedingly small; and its surface being relatively very great, the new equilibrium between the supply of heat and its loss by radiation is effected almost instantaneously. But with the increase of temperature the position of the regulating lever

is simultaneously affected, causing one or more contacts to be liberated, and as many additional resistance-coils to be thrown into circuit; the result being that the temperature of the strip varies only between very narrow limits, and that the current itself is rendered very uniform, notwithstanding considerable variation in its force, or in the resistance of the lamp, or other extraneous resistance which it is intended to regulate."

PHYSIOLOGY.

The Venom of Serpents.—The poison of serpents has generally been regarded as a sort of poisonous saliva, acting after the fashion of soluble ferments. M. Lacerda, of Rio de Janeiro, has made some observations upon the venom of a rattlesnake, which lead him to believe that this fluid contains formed ferments analogous to the Bacteria. (*Comptes rendus*, December 30, 1878.) Placing a drop of the poison upon a glass slide previously washed with alcohol, and slightly warmed, he examined it under the microscope, and saw "a sort of protoplasmic filamentous matter, formed by a cellular aggregation, arranged in an arborescent form, like that of certain Lycopodiaceæ." He observed the formation of spores within a thickened filament, which finally broke up and disappeared, setting free the spores, which then affected a linear arrangement. He describes the modes of multiplication of these spores, namely, by scission and by interior nuclei.

The phenomena observed in the blood of animals killed by the bite of the snake were as follows:—The red globules presented small bright points on the surface of the disc; these sometimes formed projections, and became more and more numerous. Finally, the globule was completely destroyed, and replaced by a number of very brilliant ovoid corpuscles, endowed with spontaneous oscillatory movements; these ovoid corpuscles did not separate from the mass of the globules, but remained within it, and the globules became fused together to form a very different amorphous paste. Alcohol swallowed, or injected beneath the skin, was found to be the best antidote.

Function of the Chlorophyll in Green Planariæ.—M. P. Geddes has experimented on a green *Planaria*, which is very abundant at Roscoff, with the view of ascertaining what is the function of the chlorophyll, which has long been known to exist in such worms. The *Planariæ* were fond of exposing themselves to the light on the bare sand in shallow water, and when placed in a small aquarium they went always towards the side from which the light came. When exposed to the sun their movements were considerably accelerated, and in a few minutes small bubbles of gas appeared here and there, and increased in number and in volume, just in the same way as with a green seaweed under similar circumstances. The gas evolved was easily collected, and in the course of the day enough was obtained to fill a small test-tube, and it appeared to be dilute oxygen by its effect upon a nearly extinguished match. By further experiments with potash, it was found to contain very little carbonic acid; and the addition of pyrogallic acid showed the presence of oxygen by the dark brown coloration produced and the ascent of the liquid in the tube. M. Geddes found that the gas produced by these *Planariæ* contained 45–55 per cent. of oxygen. The

influence of light is so essential to the existence of these animals, that after being kept in the dark they soon died. Treated with alcohol, these green *Planariæ* furnished first a yellow solution, and then a solution of chlorophyll of a magnificent green colour. The residue, coagulated and decolorised by alcohol, boiled in water and filtered, furnished a clear solution, which, treated with iodine, gave a dark blue coloration, indicative of the presence of a considerable quantity of starch.—*Comptes rendus*, December 30, 1878.

ZOOLOGY.

A Gigantic Deep-Sea Isopod.—Under the name of *Bathynomus giganteus*, M. Alphonse Milne-Edwards describes (*Comptes rendus*, January 6, 1879) an Isopod Crustacean of enormous size, dredged by Mr. Alexander Agassiz from a depth of 955 fathoms north-east of the bank of Yucatan. This animal is nearly ten inches long and four inches broad, and belongs to the great family Cymothoadæ. The most interesting point in its construction is to be found in its respiratory apparatus. The ordinary Isopods have the abdominal limbs modified to form branchiæ, but such an arrangement being apparently insufficient for this comparatively gigantic form, the abdominal feet are converted into a sort of opercular apparatus beneath which are the true branchiæ, which resemble little bushes springing from stems, dividing again and again, a structure of the respiratory organs which is quite unique among the Isopod Crustacea, although one or two forms belonging to the parasitic family Bopyridæ have branched appendages attached to the sides of the body. The position of the eyes is also peculiar. These organs, which are of remarkably large size and each composed of about 4,000 square facets, are placed on the lower surface of the head, instead of the upper surface as in the allied forms.

Mouthless Medusæ.—M. Mereschkowsky has published some curious and interesting observations made by him on two small naked-eyed Medusæ of the genus *Bougainvillea* inhabiting the White Sea (*Ann. and Mag. Nat. Hist.*, March, 1879). He describes one of these under the name of *Bougainvillea paradoxa*, as a small transparent bell about $\frac{1}{25}$ inch long, having four radiating canals, each with a red ocellus and a tuft of from three to seven tentacles at its extremity, while in the centre there is a red manubrium or stomachal peduncle with its mouth surrounded by four much-branched tentacles. The ova are developed on the surface of the manubrium, to which they remain attached for some time. Associated with these normally constructed individuals M. Mereschkowsky found Medusæ of precisely the same size and form, and showing the four canals, with their ocelli and tufts of tentacles, in fact, so far as the characters of the bell were concerned precisely identical with the others, but differing from them in the total absence of the manubrium. There was no trace of any such organ, and the four radial canals met at the summit of the bill without constituting anything that could be interpreted as a stomach. Precisely the same anomaly was observed in the second species, which is a little smaller, and is further distinguished by having the bell more globular in its lower part, but forming above a sort of cupola which renders its form very elegant. In both species the author was unable to detect anything in the shape of a stomachal cavity,

nor could he discover any direct means of communication between the vascular system and the sea-water, any aperture, however minute, through which nutritive material might have been introduced into the system of the animal, and after careful investigation he was forced to the conclusion, that these anomalous little creatures were nourished by the direct absorption through the ectoderm of organic material dissolved in sea-water. This is however, not altogether an isolated case, as M. Mereschkowsky has demonstrated that in certain sponges nourishment is effected in a similar fashion. As several of these little Medusæ occur about our own coasts, it would be an interesting point to ascertain whether any of them present analogous phenomena, and if possible to ascertain why a structure necessitating so abnormal a method of nutrition occurs.

Migrations of Aphides.—M. Lichtenstein has announced his discovery of some very curious facts in the life-history of certain aphides (*Comptes rendus*, November 18, 1878). He first detected migrations of *Phylloxera quercus* from *Quercus coccifera* to *Quercus pubescens*; and these observations were confirmed by those of M. Targioni Tozzetti upon *Phylloxera florentina*, which passes different stages of its life upon *Quercus ilex* and *Quercus pedunculata.*

M. Lichtenstein has since found that the aphis of the galls of the Pistachio (*Anopleura lentisci*) passes from those galls to the roots of at least two species of grasses (*Bromus sterilis* and *Hordeum vulgare*). He describes the development of the aphis somewhat as follows:—

In May and June the *egg* deposited on the pistachio by the fertilised female produces an apterous insect, the *Founder* (first larval form) which produces the gall, and after four moults gives birth asexually to young aphides destined to acquire wings and, after four moults, to produce the *Emigrants* (second larval form) which quit the gall, fly to the grasses, and there produce asexually apterous young, the *Budders* (third larval form), which breed asexually underground, producing several apterous generations until the appearance of nymphs which furnish the *Pupifera* (fourth larval form) which issue from the ground and fly to the Pistachio, where they deposit their pupæ which produce sexual individuals, the females of which deposit the true eggs constituting the starting point of the whole series. If this complicated development be correctly described, it is of much interest, as it may apply to many other species of aphides, and in that case would throw important light upon many points in their history.

The Gymnotus.—From an examination of a fresh specimen of *Gymnotus electricus* M. Fritsch concludes that this fish is allied to the siluroids rather than to the eels. He founds this opinion especially upon the structure of the brain, which has the olfactory tubercles small and the cerebellum very large, as in the Siluroidei; whereas in the true eels these parts present exactly the opposite character. Further, in the *Gymnotus*, as in the siluroids, the maxillaries are rudimentary, and the margin of the upper jaw is formed by the intermaxillaries; in the Murænoids, on the contrary, the maxillaries form parts of this margin and bear teeth. The structure of the opercula constitutes another agreement with the Siluroids. From a consideration of these and other characters M. Fritsch is inclined to place the Gymnotini close to the Malapterurini, which also include an

electrical species. The denomination "Electrical Eel" thus becomes a misnomer for the *Gymnotus.—Sitzungsberichte der Gesellsch. naturforsch. Freunde zu Berlin*, 1878.

Sir John Lubbock on Ants.—Sir John Lubbock read two papers on ants at the Linnean Society on February 6. The first gave an account of their anatomy; but, from the extreme complexity of these interesting little creatures, it would be impossible to make this communication intelligible without the figures. The second paper was a continuation of his observations on the habits of ants. He mentioned that he had at first isolated his nests by means of water. This was effectual enough, but, especially in summer, the water required to be continually renewed. Kerner, however, had suggested that the hairs of plants served to prevent ants from obtaining access to the honey, and it accordingly occurred to him that strips of fur arranged with the points of the hairs downwards might answer his purpose. He had tried this; and finding it successful, he thought a similar arrangement might perhaps be found useful in hot countries.

It is generally stated that the queen ants alone lay eggs, but Sir John has found that in most of his nests some few of the workers are capable of doing so. It appears, however, that these eggs always produce males. In the case of bees we know that the queen is fed on a special kind of food. In ants it is not possible to make observations similar to those by which in bees this has been established. It is, however, rendered more than probable by the fact that while males and workers have been bred by hundreds in his nests, no queen has yet been produced.

It is well known that ants keep other species of insects in their nests, which they use just as we do cows, &c.

The "Mat. p. l'Hist. prim. de l'Homme" for 1869 contains a short but interesting account by M. Lespes of some experiments made by him on the relations existing between ants and their domestic animals, from which it might be inferred that even within the limits of a single species some communities are more advanced than others. He found that specimens of the blind beetle, *Claviger Duvalii*, which always occurs with ants, when transferred from a nest of *Lasius niger* to another which kept none of these domestic beetles, were invariably attacked and eaten. From this he infers that the intelligence necessary to keep *Clavigers* is not coextensive with the species, but belongs only to certain communities and races, which, so to speak, are more advanced in civilisation than the rest of the species.

Sir John Lubbock, however, removed specimens of the curious *Platyarthrus* from one nest to another, but they were always amicably received. He even transferred specimens from a nest of *Lasius flavus* to one of *Formica fusca*, with the same result.

As regards the longevity of ants he has now two queens of *F. fusca*, which seem quite in good health, and which have lived with him since 1874; they are therefore probably five years old. He has also workers of *Lasius niger*, *Formica sanguinea*, *F. fusca*, and *F. cinerea*, which he has had under observation since 1875.

In his previous papers he had given various instances which seem to show that ants do not exhibit such unvarying kindness to their friends as has been usually supposed. He wished to guard himself, however, against being sup-

posed to question the general good qualities of his favourites. In fact, ants of the same nest never quarrel among themselves; he had never seen any evidence of ill-temper in any of his nests. All is harmony. He had already in previous papers given various instances of tender kindness. Again, in one of his nests of *Formica fusca* was a poor ant which had come into the world without antennæ. Never having previously met with such a case, he watched her with great interest, but she never appeared to leave the nest. At length one day he found her wandering about in an aimless sort of manner, and apparently not knowing her way at all. After a while she fell in with some specimens of *Lasius flavus*, who directly attacked her. He then set himself to separate them, but she was evidently much wounded, and lay helplessly on the ground. After some time another *Formica fusca* from her nest came by. She examined the poor sufferer carefully, then picked her up tenderly, and carried her away into the nest. It would have been difficult, Sir John thinks, for anyone who witnessed this scene to have denied to this ant the possession of humane feelings.

It is clear, from the experiments recorded in the present and in Sir John's former papers, that the ants recognise all their fellows in the same nest, but it is very difficult to understand how this can be effected. The nests vary very much in size, but in some species 100,000 individuals may probably be by no means an unusual number, and in some instances even this is largely exceeded. Now, it seems almost incredible that in such cases every ant knows every other one by sight; neither does it seem possible that all the ants in each nest should be characterised from those of other nests by any peculiarity. It has been suggested in the case of bees that each nest might have some sign or password. The whole subject is full of difficulty. It occurred to Sir John, however, that experiments with pupæ might throw some light on the subject. Although the ants of every separate nest, say of *Formica fusca*, are deadly enemies, still if larvæ or pupæ from one nest are transferred to another, they are kindly received and tended with, apparently, as much care as if they really belonged to the nest. In ant warfare, though sex is no protection, the young are spared—at least when they belong to the same species.

Moreover, though the habits and dispositions of ants are greatly changed if they are taken away from their nest and kept in solitary confinement, or only with a few friends, still under such circumstances they will often carefully tend any young which may be confided to them. Now, if the recognition were effected by means of some signal or password, then, as it can hardly be supposed that the larvæ or pupæ would be sufficiently intelligent to appreciate, still less to remember it, the pupæ which were entrusted to ants from another nest would have the password, if any, of that nest, and not of the one from which they had been taken. Hence, if the recognition were effected by some password, or sign with the antennæ, they would be amicably received in the nest from which their nurses had been taken, but not in their own.

He therefore took a number of pupæ out of some of his nests of *Formica fusca* and *Lasius niger*, and put them in small glasses, some with ants from their own nest, some with ants of another nest of the same species. The results were that thirty-two ants belonging to *Formica fusca* and *Lasius niger*,

removed from their nest as pupæ, attended by friends and restored to their own nest, were all amicably received. What is still more remarkable, of twenty-two ants belonging to *Formica fusca*, removed as pupæ, attended by strangers and returned to their own nest, twenty were amicably received. As regards one, Sir John was doubtful; the last was crippled in coming out of the pupæ case, and to this, perhaps, her unfriendly reception may have been due. Of the same number of *Lasius niger* developed in the same manner from pupæ tended by strangers belonging to the same species, and then returned into their own nest, seventeen were amicably received, three were attacked, and of about two Sir John felt doubtful.

On the other hand, fifteen specimens belonging to the same species, removed as pupæ, tended by strangers belonging to the same species, and then put into the strangers' nest, were all attacked.

The results may be tabulated as follows:—

	Pupæ brought up by friends and replaced in their own nest.	Pupæ brought up by strangers. Put back in own nest.	Pupæ brought up by strangers. Put in strangers' nest.
Attacked	0	7*	15
Received amicably	33	37	0

Sir John intends to make further experiments in this direction, but the above results seem very interesting. They appear to indicate that ants of the same nest do not recognise one another by any password. On the other hand, if ants are removed from the nest in the pupa state, tended by strangers, and then restored, some at least of their relatives are certainly puzzled, and in many cases doubt their claim to consanguinity. Strangers, under the same circumstances, would be immediately attacked; these ants, on the contrary, were in every case—sometimes, however, after examination—amicably received by the majority of the colony, and it was often several hours before they came across one who did not recognise them.—*Nature*, February 20, 1879.

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* Of about three of these Sir John did not feel sure.

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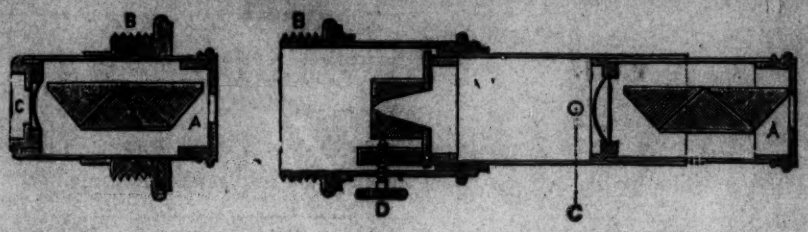

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